

# **NOAA Technical Memorandum NMFS**



**DECEMBER 1992**

## **HAWAIIAN MONK SEAL OBSERVATIONS AT FRENCH FRIGATE SHOALS, 1984**

Julie J. Eliason  
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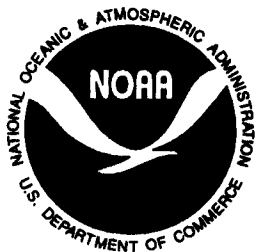
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## **NOAA Technical Memorandum NMFS**

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## **NOAA Technical Memorandum NMFS**

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**ABSTRACT**

Research on the Hawaiian monk seal, *Monachus schauinslandi*, was conducted at French Frigate Shoals in the Northwestern Hawaiian Islands during 26 December 1983-27 January 1984, 7 March-31 August, and 16-20 October 1984. Data were collected on population structure, reproduction, and factors affecting survival. Four atoll-wide counts in January yielded a mean of 221 seals (including pups), and a total of 369 seals were identified during the year. An estimated 106 pups were born in 1984; 7 died before weaning. Fifty male pups and 42 female pups were tagged. Approximately 92% of births were on the three major pupping islands (East, Round, and Whale-Skate Islands). At least 19.8% of parturient females exchanged pups during the nursing period. The mean lactation period for 24 females whose lactation period was known within 5 days was 38.4 days. Interatoll movement was documented for nine seals. First-year survival of pups marked in 1983 was 83%. Eighteen seals were observed with injuries, five of which were considered severe. Two seals were found entangled in debris. Twelve seals, including pups, either died or disappeared, and necropsies were performed on four. Seven prematurely weaned pups were captured and sent to Honolulu for rehabilitation.

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## INTRODUCTION

French Frigate Shoals (FFS; lat. 23°45'N, long. 166°10'W), a coral atoll located 490 nmi northwest of Oahu in the Hawaiian Archipelago, is the largest haul-out and pupping area for the endangered Hawaiian monk seal, *Monachus schauinslandi*. The crescent-shaped atoll consists of 1 large volcanic pinnacle and 11 sandy islets (Fig. 1). Tern Island was expanded and occupied by the U.S. Navy in 1942, followed by the U.S. Coast Guard in 1952. In mid-1979, the U.S. Fish and Wildlife Service (USFWS) assumed responsibility for the island, and now three to four personnel are stationed there year-round. Information on the history, geology, climate, and vegetation of FFS is summarized in Amerson (1971).

From 1958 to 1979, research on seals at FFS comprised only occasional censuses. Since that time, annual monitoring of seals has been conducted by the National Marine Fisheries Service (NMFS) and the USFWS (Johnson and Johnson 1984). In 1983, a more extensive monk seal research program was initiated by the Honolulu Laboratory of the Southwest Fisheries Science Center, NMFS, NOAA. Data are summarized annually and presented in the NOAA Technical Memorandum Series. This report summarizes data collected during the 1984 field season.

The research objectives in 1984 included the following: conduct censuses on all islands; identify individual seals; monitor reproduction and pup survival; estimate survival of yearlings; establish and update pupping histories for individual females; monitor exchanges of pups among nursing females; determine female lactation periods; tag weaned pups; document injuries, entanglements, disappearances, and deaths; perform necropsies; collect scat and spew samples; capture undersized pups for rehabilitation; and inventory and destroy debris capable of entangling wildlife.

## METHODS

### Study Period and Area

Research was conducted by NMFS personnel at FFS during 26 December 1983-27 January 1984, 7 March-31 August, and 16-20 October 1984 (Appendix A). This field season was somewhat longer than normal, with the December-January effort an exception from other years. The NMFS personnel varied during the field season (Appendix A); staff of the USFWS Hawaiian Islands National Wildlife Refuge were present the entire year. Field camps established on East and Whale-Skate Islands were occupied for 1-5 successive days; Tern Island was used as a research base camp for supplies and refueling.

Eleven low, sandy islands were present: Six islands (East, Gin, Little Gin, Tern, Trig, and Whale-Skate Islands) were permanent, and five (Bare, Disappearing, Mullet, Round, and Shark

Islands) were more ephemeral, historically being overwashed and disappearing during periods of high surf or tides. Of these five, Round and Shark Islands were present the entire year. Bare Island was present at low tide as a pile of coral rubble, but was submerged during high tide. Disappearing Island was present until 6 June, but it was found to be overwashed during a subsequent census on 26 June, had disappeared completely by 7 July, and did not reappear before NMFS personnel departed on 31 August. Mullet Island was present on 23 March, but was awash on 30 March and thereafter until at least 31 August.

Other ephemeral sand spits appeared periodically. A small sand spit appeared east of East Island for 1 day. Spits appearing south of Little Gin Island were considered adjuncts to that island. Similarly, spits appearing north of Gin Island were considered part of that island.

### Identification of Individuals

A previously established permanent monk seal identification file was updated periodically by using one or more of the following: photographs of seals with flipper tags, identifiable scars, and natural bleach marks. Seals included in the permanent identification files were considered to be "known" animals and were assigned a three-digit number with a Y prefix denoting that the seal was first identified at FFS. This letter-number combination constituted the identification (ID) number for the seal. Unidentified seals with scars or natural bleach marks sufficiently unique to distinguish them from all other seals were added to the identification file and assigned new numbers.

Emphasis was placed on identifying adult female seals, particularly parturient females, in order to monitor their reproductive activity. Scar cards were drawn for parturient females and attempts were made to match them to seals that had pupped in previous years. Parturient females were assigned temporary field numbers according to the island of parturition (e.g., E-1, E-2, and so on if parturient on East Island). If a female was subsequently determined to be a known seal, the temporary number was replaced by her permanent ID number. At the end of the field season, parturient females not matched to previously known individuals were assigned a P number according to island of parturition. For example, a seal parturient on East Island was designated P-E-1, and a seal parturient on Whale-Skate Island was designated P-W-1. Many females identified as parturient and assigned temporary ID numbers were re-identified in subsequent field seasons (1988-90) and assigned permanent ID numbers which have been included in this report.

Any resightings of the 94 weaned pups and 1 juvenile that had been temporarily bleach marked with two-letter codes in 1983 were documented to monitor yearling survival.



### Tagging

Weaned pups were tagged between the fourth and fifth digits of each hind flipper with yellow Temple Tags®. Tags were inscribed with a *T*, indicating the year of tagging, followed by a two- or three-digit number. Tag numbers were in most cases identical on each flipper, although lost tags were replaced with numbers different from the original. At the time of tagging, the pup's body length and axillary girth were measured. Body length was measured dorsally along a straight line from the tip of the snout to the tip of the tail.

### Censuses

The USFWS biologists conducted censuses on Tern Island every 4 days and on some of the other islands approximately every 36 days throughout the year. All other censuses were conducted by one or two NMFS biologists. A 5-m-long Boston Whaler was used to travel between the islands. An attempt was made to census each island in the atoll at least once per week, although weather conditions and boat malfunctions often disrupted this schedule. Most counts were made from land; however, inaccessible islands (small islands where seals might have been disturbed by landing, and islands where sea conditions prevented landing) were censused with binoculars from the boat.

A count of seals was considered a census if all seals on an island were counted and all associations among the seals were recorded. Censuses were conducted between 1300 and 1530 hours (Hawaii standard time) whenever possible; however, because of time to travel between islands and the necessity to take advantage of favorable weather conditions, islands were frequently censused at other times. When biologists were present on one island for several days in succession, censuses were performed every other day. The length of time necessary to census one island ranged from an instantaneous count to 2.5 hours. The census data recorded for each island included time, weather conditions, permanent IDs of known seals, tag numbers, size class, sex, degree of molt, island sector, beach position, association with other animals, and behavior. Seals accompanied by nursing pups were recorded as adult females; otherwise, the sex was recorded only if the ventral side of the seal was seen or if an individual could be identified by scars, flipper tags, or natural bleach marks. Seals in the water were recorded but not included in census totals. Census techniques are detailed in Stone (1984). A census was considered to be an atoll-wide count if all islands of FFS were surveyed within a 2-day interval.

### Patrols

Unlike censuses, patrols were conducted by one or two observers on an opportunistic basis and may not have included all seals or all associations among seals. They ranged in duration

from single observations to approximately 3 hours. Data collected during patrols included seal interactions, known animal sightings, and reproduction information.

### **Reproduction**

When observers were camped on Whale-Skate or East Island, reproductive data were recorded twice daily. Every morning at approximately 0800 hours and again in late afternoon or early evening, a patrol was conducted to note births and weanings. Reproductive data on seals at other islands were collected during censuses, or on patrols immediately after censuses.

Several types of reproductive data were collected: identity of the mother (either field or permanent ID number), island, sector, birth date, size and sex of pup, pup's degree of molt during the observation and at weaning, and weaning date. Nursing pups were assigned to one of the following size classes: P1 signified a newborn, small, wrinkled unmolted pup; P2 signified a small, unmolted pup that had lost its wrinkled appearance; P3, a plump, unmolted pup; P4, a molting pup; and P5, a completely molted pup. Births and weanings during the time interval between surveys of an island were considered to have occurred on any day during that interval, from the day after the previous visit until the day of the subsequent visit.

Pup production on all islands except Round Island was determined by summing all births recorded. However, because it was not possible to land on Round Island without disturbing nursing pairs, pup production there was estimated by two methods. One method was to track the size progression of pups on successive censuses. Small (P1) pups which could not be "accounted for" were considered to be new births, and large (P5) pups not accompanied by a female were considered to have weaned. The second method was to tally at tagging the number of pups considered to have weaned on Round Island. These included pups tagged on Round Island late in the field season when no nursing females were present, as well as pups tagged on islands other than Round Island, but definitely not weaned from that island (i.e., older weaned pups).

### **Pup Exchanges**

Exchanges of nursing pups among adult females were documented if at least one of the following criteria was met: (1) direct observation of an exchange; (2) the sex of pup differed in successive observations; (3) the pup's size differed greatly in successive observations, or (4) the natural marking allowed positive identification of an exchanged individual.

## **Injuries**

When an injured seal was observed, the island, size class, and sex of the animal were recorded, and the injury was photographed if possible. If the injured seal was identified, its permanent identification file and its photograph file were updated with the new information. Progression and healing of injuries were documented whenever injured seals were resighted.

## **Deaths**

Dead seals were photographed and measured. Endoparasites and stomach contents were collected, and gross abnormalities were recorded. Tissue samples of major organs were preserved in 10% formalin. If the specimen was fresh, a set of tissue samples was also frozen. Skulls were flensed and either frozen or dried.

## **Collection of Scats and Spews**

Seal scats and spews were collected and stored in plastic bags. Samples of the freshest scats from seals of all size classes were frozen for hormone analysis, and samples of most spews were frozen for ciguatera testing. The remaining scat and spew samples were processed under running seawater through a series of three sieves (2.80, 1.18, and 0.71 mm mesh). Recorded were the date, island, sector, degree of freshness (wet or dry), size class, and ID number of the seal if known. Representative samples of the remaining hard parts were stored in vials containing 90% alcohol for keying to prey species.

## **Rehabilitation Program**

Undersized pups were captured for rehabilitation. Selection was based on excessively small axillary girth, although no strict criterion was established. Pups were taken to Tern Island and were force-fed pieces of fish for 2-6 days and then flown to Honolulu via chartered aircraft.

## **RESULTS AND DISCUSSION**

### **Population Structure**

#### **Identified Individuals**

Several changes were made to the file of permanently identified seals at FFS. Four seals were found to have been assigned duplicate ID numbers: Seal Y009 originally was Y176; Y046 was Y234; Y146 was Y260, and Y203 was Y154. ID numbers Y176, Y234, Y260, and Y154 were deleted from the permanent ID files. Also, two different adult females had been assigned ID Y138; therefore, a new number (Y286) was assigned to one animal, and appropriate photographs were added to the files. Similarly, two adult males had previously been assigned ID Y160. One of

these was removed from the file of known seals because the scars were poorly documented, while the second seal retained ID Y160. An adult female (Y183) had been incorrectly listed as a male, and the file was corrected accordingly. One seal (ID Y158) was reclassified from juvenile to subadult, and four seals (IDs Y141, Y148, Y238, and Y265) were reclassified from subadult to adult.

Additional seals with identifiable characteristics were added to the files during and after the 1984 field season. The number of identified seals sighted in 1984 was 369: 52 adult males, 124 adult females, 9 subadult males, 12 subadult females, 36 juvenile males, 44 juvenile females, 50 weaned male pups, and 42 weaned female pups.

### **Atoll-Wide Counts**

Although atoll-wide counts were not considered a high priority, four were completed (Appendix B), providing a mean of 221.0 seals ( $SD = 28.2$ ). All four atoll-wide counts were conducted in January; hence, no pups were present. Island-use patterns by seals may differ seasonally, precluding direct comparison of these mid-winter counts with spring or summer atoll-wide counts made in other years.

### **Censuses**

Census results are in Table 1. To allow comparison with counts from other years when data were collected only in March-September, total counts from that 7-month interval also are presented. Counts are summarized individually in Appendix C.

## **Reproduction**

### **Pup Production**

The estimated total pup production was 106. Births occurred on 7 islands: East, 44; Gin, 1; Little Gin, 5; Round, 24; Tern, 1; Trig, 2; and Whale-Skate, 29. Ninety-two pups were tagged (50 males and 42 females; Table 2). Nineteen of the tagged pups were likely weaned on Round Island. However, a second estimate of pup production on Round Island, 24 pups, was obtained by monitoring the size progression of pups. Thus, either the size progression method overestimated the number of pups born on Round Island, or five pups which weaned from Round Island were never tagged. Because pups may have dispersed to other islands within the atoll, thereby not being sighted, the latter possibility is more likely.

Pre-weaning mortality was seven pups or 6.6%. Five stillbirths occurred at East, Tern, Trig, and Whale-Skate Islands. Pups were considered to have been stillborn if they were found dead under one or more of the following conditions:

- (1) Pup was small and had a wrinkled, newborn appearance.
- (2) Pup was still attached to the placenta by the umbilicus.
- (3) A fresh placenta was located near the pup.
- (4) Fresh blood was on the pup and vaginal area of the mother.

One pup died during its first two weeks, and one pup disappeared less than 1 day after birth.

Two pups disappeared after weaning and prior to being tagged, and one unconfirmed mortality of an untagged (and possibly prematurely weaned) pup was observed from a distance on Round Island.

The pupping season extended from early February to mid-September, with the greatest number of births occurring in May (Fig. 2). Maximum pup production occurred in April and May on East Island, May and June on Whale-Skate Island, and June on Round Island (Fig. 2). One pup on Little Gin Island had weaned prior to the arrival of the NMFS research team on 12 March. Only two pups, both on East Island, were born after 30 August. These pups were weaned between 21 September and 17 October (G. Fairaizl, USFWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., October 1984).

A total of 81 parturient females were identified and documented on the basis of natural markings (Table 3) and assigned either provisional or permanent ID numbers. Most females parturient on Round Island have been excluded from this table; since they were observed only from a boat at a distance, only heavily scarred females were recognizable.

### **Pup Exchanges**

Monitoring pup exchanges was difficult for the following reasons: (1) Several islands were visited infrequently; (2) female-pup pairs frequently moved to different sectors on their pupping islands; (3) pups were difficult to classify to age and sex, because many female-pup pairs were swimming when observed; and (4) few pups had natural bleach marks for unique identification. Nevertheless, several pup exchanges were detected on East and Whale-Skate Islands. At least 21 of the 106 parturient females were known to have fostered pups during the nursing period. Twelve females weaned pups born to other females, and nine females were known to have exchanged pups temporarily. Multiple exchanges were common among the 21 females who fostered other pups: 10 females exchanged pups at least once during the nursing period; 6 females exchanged at least twice; 4 females exchanged at least three times; and 1 female exchanged at

least four times. One female (ID Y283) exchanged pups at least three times and nursed four different pups during her lactation of 39-55 days. Another female (ID Y203) exchanged pups at least four times and nursed three different pups during her 34-day lactation. Sixteen of the 20 females known to have exchanged pups gave birth on East Island, and the remaining 4 pupped on Whale-Skate Island.

### **Lactation Periods**

Because intervals between visits to the pupping islands were variable, exact birth and weaning dates for most pups were unknown, and lactation periods were usually determined only as a range (Table 3). Mean lactation periods were calculated from midpoints of each range when the lactation period was known within 5 days. Based on this approximation, 24 females nursed for an average 38.2 days, (range, 32-48 days). Nineteen females parturient on East Island nursed for an average 39.0 days, and 5 females parturient on Whale-Skate Island nursed for an average 35.1 days. Because the variance about the midpoint of the interval was unknown, a statistical test for differences between the two islands was not conducted.

Because pups may be exchanged among nursing females, mean lactation periods for females are not the same as mean nursing periods for pups, which may suckle for a longer or shorter duration depending on the condition of the foster mother. For example, a pup (ID Y335) on Whale-Skate Island nursed from two different females for a minimum of 65 days. The pup initially weaned from its presumed mother (ID Y570) on 12 July after a lactation period of 34-38 days and was tagged on that date. On 18 July, the pup was observed nursing from another female (ID Y568) whose newborn pup had died on 13 July. The female fostered Y335 for an additional 31-40 days. Another weaned pup (Y332) nursed for 2 days from a foster mother (Y529) whose own pup had already weaned. Alcorn (1984) and Alcorn and Henderson (1984) reported a pup nursing from a foster mother on Laysan Island for an entire additional nursing period in 1982.

Evidence of twin births in monk seals has been only circumstantial. In 1983, a female (Y190) was observed on Whale-Skate Island with two newborn pups. Furthermore, she nursed both of them through a normal weaning period, although neither survived their first year (NMFS unpubl. data). Similarly, an adult female seal may have given birth to twins in 1984. The seal was observed 29 May on Round Island with two pups that were size-classed as less than 2 weeks old; one pup appeared to be slightly larger than the other. The female was again observed on 3 June, nursing both pups, but none of the three was observed thereafter. Monk seal females have simultaneously nursed two pups which were not twins (Alcorn and Henderson 1984; Boness 1990), and a high incidence of fostering has been documented at FFS (Boness 1990). The 1984 incident therefore cannot with any

certainty be attributed to twinning.

#### **Birth on Tern Island**

Prior to 1979, few monk seals used Tern Island as a haul-out area (Kenyon 1966, 1972; DeLong and Brownell 1977; Fiscus et al. 1978; Rauzon et al. 1978). After the USFWS assumed responsibility of Tern Island from the U.S. Coast Guard, the number of seals using the island as a haul-out area dramatically increased (Schulmeister 1981). The increase probably results from the reduction in disturbance to animals by humans. Although Tern Island is now regularly used as a haul-out area by many seals and contributes a high fraction of the total seals ashore at FFS, no past records exist of live births of monk seals on the island. In January and February 1983, two aborted fetuses were collected from Tern Island (W. Gilmartin, Honolulu Laboratory, pers. commun., September 1984).

The first recorded birth on Tern Island for which the pregnancy was carried full-term or nearly full-term occurred in 1984. On 3 May, adult female Y110 was observed on the beach with a dead newborn pup. This female had no known prior pupping history. This incident may indicate that young females without established pupping islands may pup on Tern Island now that human disturbance has been reduced. However, Tern Island is unlikely to become an important pupping island because it lacks protected beaches (Westlake and Gilmartin 1990).

#### **Mating Incident**

One mating incident was observed at Tern Island on 16 July. When first observed at 0930 hours on 16 July, an adult male and adult female were hauled out and occasionally vocalizing at each other. The female was thin and unmolted, suggesting she had recently weaned a pup. When a second adult male approached the pair, the two males vocalized and jostled with each other. After a subadult male approached the group of seals, the three lay quietly on the beach until a fourth male rapidly approached them and vocalized loudly. The other males then began to bite the female's back and occasionally each other. The female made no attempt to escape, although she did attempt to drive the males away. After approximately 5-10 minutes, the female moved into the water where she floated without fleeing. Two males were observed with erect penises as they attempted to mount the female, although actual intromission was not observed. Vigorous mounting activity continued for 10 minutes and then gradually subsided. Observations ceased when the group moved away from shore towards deeper water off the northwest side of Tern Island. No injuries were observed on the female during the incident, and because her identity was not known, she was not detected hauled out on any island after the incident.

### Interatoll Movement

Interatoll movement was documented for nine seals which moved between FFS and other locations (Table 4). Six seals moved between FFS and Necker Island, two seals made round-trips between FFS and Laysan Island, and one seal moved to FFS from Lisianski Island.

### First Year Survival

Of the 94 weaned pups marked in 1983, 78 (83%) were resighted in 1984. Seventy four yearlings were resighted at FFS, three were resighted at Necker Island, and one was sighted at both FFS and Necker Island. First-year survival estimated by resightings later in the year was lower because five yearlings died or disappeared between January and March. Thus first-year survival estimated solely on resighting from spring and summer observations was 73 of 94 seals (77.7%).

### Factors Affecting Survival

#### Injuries

Eighteen seals were observed with injuries of varying degrees; five of the injuries were considered severe (Table 5). Monitoring the progress of injured seals was difficult because visits to the islands were infrequent and often short in duration and seals often moved among the islands.

*Shark related injuries.*--Five (27.8%) of the 18 injuries observed were attributed to shark attacks (Table 5); this is comparable to the 24% reported for FFS in 1980-81 by S. Schulmeister, (USFWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., 1982), who noted that most shark-related injuries were observed in March. In 1984, they were observed from April to August.

One seal (adult male Y131) injured by a shark was observed several times throughout the field season, allowing observers to monitor the progress of its wound. The animal was first observed on 30 April at Tern Island with a fresh shark wound on its right side. The wound was approximately 30 x 25 cm, and the seal appeared emaciated and weak (Fig. 3A). The seal was resighted on 13 June: The wound was healing, although the seal was still slightly emaciated (Fig. 3B). When the seal was resighted on 10 August, the wound had healed completely (Fig. 3C), and the seal appeared healthier and more active. The rapid healing of this wound in approximately 3 months indicates that Hawaiian monk seals can recover quickly from massive injuries.

No shark attacks were observed in 1984, although 3- to 4-m-long tiger sharks, *Galeocerdo cuvieri*, were observed patrolling the shore near East Island. Groups of 20-50 gray reef sharks, *Carcharhinus amblyrhynchos*, were also observed near many of the



islands. Monk seal remains have been found in three tiger sharks at FFS: (Taylor and Naftel 1978): Balazs and Whittow (1979) observed a tiger shark feeding on a monk seal carcass, and two large tiger sharks killed a subadult monk seal at Laysan Island (Alcorn and Kam 1986).

*Adult male-inflicted injuries.*-- Three seals were observed with large open wounds along the dorsal midline, and four seals had dorsal lumps which appeared to be abscesses (Table 5). All of these injuries were observed in July and August. These wounds are suggestive of wounds inflicted by adult males during mating attempts and agonistic encounters. Adult male monk seals occasionally inflict wounds on adult females during mass mating attempts (Johnson and Johnson 1981; Gilmartin 1983; Alcorn 1984; Johanos and Kam 1986; Johanos and Austin 1988) and may also wound immature seals during attempted mounts and agonistic encounters (Wirtz 1968; Johnson and Johnson 1978). Although we never observed an adult male injuring an immature animal, males occasionally approached, investigated, mouthed, and attempted to mount immature seals and weaned pups.

### **Entanglements**

Two seals were found entangled in debris during the 1984 field season (Table 6). These entanglements have been reported by Henderson (1985) and are described in more detail below.

*Case 1.*--On 6 June on Tern Island, a subadult seal of unknown sex was observed with the rim of a plastic bucket tightly encircling its neck. The rim had cut into the skin, and the seal's neck was bleeding (Fig. 4). The seal was resighted on 7 June, on Tern Island and an unsuccessful attempt was made to restrain the seal in order to remove the ring. The seal was sighted for the last time on 11 June on Whale-Skate Island; the ring was still around its neck, and no attempt was made to remove it.

*Case 2.*--On 9 June, on Gin Island, a male yearling was observed with its neck and axillary area entangled in a fishing net. This seal was a bleached yearling (GA) which had not been sighted since August 1983. The net tightly constricted the seal's neck, although no open wound was observed. The net was made of 0.3 cm diameter polypropylene and was approximately 3 x 0.5 m in size with a 5.5 cm stretch mesh size. The seal was freed from the net and released.

### **Net and Rope Inventory**

A total of 168 debris fragments capable of entangling seals and sea turtles were inventoried. Samples were taken from 143 fragments found on the beaches, and the remainder were burned to prevent possible entanglement of animals.

### Deaths

Twelve deaths or disappearances were documented (Table 7). Four necropsies were performed, including one of a newborn pup (Appendix D). Two newborn pup carcasses were frozen intact. Descriptions of each death and disappearance follow.

Case 1.--On 26 February, an adult female was observed guarding a dead newborn pup on Trig Island. The placenta was located a short distance from the pup which appeared to be stillborn (G. Fairaizl, USFWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., March 1984). The island was visited next on 10 March when the skull of the decomposed carcass was collected.

Case 2.--On 10 March, adult female Y145 was observed on Round Island with two pups located near her ventrum. One pup was size-classed P1, and the second pup was size-classed P2. On 12 March, this female was observed nursing only the smaller pup. The larger pup was approximately 5 m away near the shoreline. On 16 March, the larger pup had disappeared and was not observed again. The pup had probably been prematurely abandoned by another female and either drowned or was taken by sharks.

Case 3.--On 25 March adult female Y144 was observed on Whale-Skate Island vocalizing near a dead newborn male pup which was still attached to the placenta. When the female was chased into the water by an adult male, observers removed the carcass from the area. Postmortem autolysis was too severe for adequate histologic appraisal, although the pup was probably stillborn (necropsy No. JJE001, Appendix D).

Case 4.--At 0910 hours on 12 April, a female yearling, bleach marked EV, was seen on Tern Island and was noted as being emaciated. At 1730 hours, the seal was found dead, lying on its dorsum with its head and neck extended backwards. No external injuries were noted. The seal weighed only 18.2 kg (about the weight of a newborn), suggesting it starved to death (necropsy No. JJE002, Appendix D).

Case 5.--A dead newborn pup was discovered 16 April on East Island. Adult female Y461 was lying on top of the pup. Fresh blood on the pup and female indicated a recent birth. The female guarded the dead pup until 21 April when the pup's carcass was recovered. A necropsy was not performed because the pup was crushed and badly decomposed.

Case 6.--Adult female Y110, with her newborn dead female pup, was observed 3 May on Tern Island. The female frequently moved back and forth along the beach, vocalizing. No placenta was observed in the area. The carcass was removed from the beach and frozen intact. The female continued to vocalize and frequent the area for 2 days after the removal of her pup.

Case 7.--A dead juvenile female was discovered on Whale-Skate Island on 19 May. The seal was lying on its ventrum near the beach crest and appeared to have been dead approximately 2-3 days. The body was slightly bloated, and blood was present around the nostrils and mouth. Although the seal did not appear emaciated, its stomach and intestine were empty. Postmortem autolysis was too severe for adequate histologic appraisal (necropsy No. JJE005, Appendix D).

Case 8.--A badly decomposed carcass of a young pup was found on Whale-Skate Island on 22 May. The carcass was partially buried in the sand at the high tide mark. The pup appeared to have been dead approximately 1 month, although the carcass had not been discovered during previous censuses of the island. The carcass had probably been buried in the sand and had recently become uncovered. This carcass was probably a 2-week-old nursing pup from female Y206 which had disappeared between 17 and 20 April.

Case 9.--On 13 June on East Island, an adult female, which had been nursing a 4-week-old male pup, was observed with a P2 female pup. The adult departed the island on 15 June. The female pup was tagged T24 (ID Y313) on that date and was observed on 16, 18, and 20 June, but was never observed thereafter.

Case 10.--On 26 June, adult female Y286 gave birth to a pup of unknown sex on East Island. The next morning at 0030 hours, both the female and pup were heard vocalizing. At 0430 hours, the female was heard vocalizing, but not the pup. Two hours later, the female was at the shoreline, and the pup was gone. The birth had occurred above a 2-foot-tall escarpment where sand had been cut away by tidal surge. The pup may have crawled or fallen down this beach slope into the water. Its body was never found.

Case 11.--On 13 July, adult female (ID Y568) was observed attending a dead newborn pup on Whale-Skate Island. The umbilicus was broken, and the placenta was located 1.8 m from the pup. When the carcass was recovered, no external injuries were apparent. The carcass was frozen intact.

Case 12.--On 2 August, an adult male was observed on Whale-Skate Island. The seal was extremely emaciated and appeared to be very weak. On 3 August, the seal was sighted again in the same location at approximately 1600 hours. On the morning of 4 August, the seal was found dead, bleeding from the nostrils. Histological examination revealed debilitating lung pathology of unknown cause (necropsy No. JJE008, Appendix D).

## Miscellaneous

### Scats and Spews

Twenty-four scat samples were collected and 20 were frozen for hormone analysis. Thirty-five spew samples were collected, and 26 were frozen for ciguatera toxin testing. The results will be reported after analyses have been completed.

### Rehabilitation Program

In 1984 a program was initiated to test the feasibility of collecting and rehabilitating underdeveloped pups for eventual relocation to islands with depleted populations. Seven prematurely weaned pups, four females (Y290, Y299, Y319, and Y324) and three males (Y291, Y294 and Y346) were captured and sent to Honolulu for rehabilitation. Three of the females (Y290, Y299, and Y319) were relocated to Kure Atoll in June 1985 (Reddy and Griffith 1988) and were known to be alive there as of March 1991 (NMFS unpubl. data). The fourth female (Y324) died in Honolulu as a result of a septal heart defect. Two of the males (Y294 and Y346) were kept in permanent captivity as research animals. The third male (Y291) was relocated to Kure Atoll shortly after his capture from French Frigate Shoals in 1984 and was found dead there in early 1985.

### "Entanglement" in Filamentous Substance

Weaned pups were occasionally observed with dried mucus-like filaments cemented onto the mouth and head area. On 6 May, one weaned pup was observed at East Island with a small amount of dried filamentous material on its muzzle. When this seal was observed again on 12 May, the filaments had accumulated into a larger flap of material which suspended from the pup's palate. The seal opened and closed its mouth and shook its head, apparently attempting to free the substance. By 20 May, the filamentous matter had greatly accumulated so that the seal's entire muzzle area appeared to be entangled in a fine net, which bound shut the pup's mouth, eyes, and nostrils (Fig. 5). Field personnel removed as much substance as possible from the eyes, nostrils, and mouth. When the seal was observed again on 30 May, dried filaments had again accumulated around the seal's mouth, binding it shut, and the filaments were again removed. Another weaned pup on East Island (ID Y301) was observed with hardened filaments which bound shut its mouth and one eye. An observer removed the filaments from the seal's eye but could not free the mouth before the seal fled.

Weaned monk seal pups have been observed playing with and attempting to consume sea cucumbers (*Holothuria* sp.), which when disturbed will expel part of the respiratory tree or will eviscerate the entire tree and gonads. The substance on the

pups' faces was likely dried viscera, which could temporarily bind shut a pup's mouth.

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#### CITATIONS

- Alcorn, D. J.  
1984. The Hawaiian monk seal on Laysan Island: 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-42, 37 p.
- Alcorn, D. J., and E. K. Buelna.  
1989. The Hawaiian monk seal on Laysan Island, 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-124, 46 p.
- Alcorn, D. J., and J. R. Henderson.  
1984. Resumption of nursing in "weaned" Hawaiian monk seal pups. 'Elepaio 45(2):11-12.
- Alcorn, D. J., and A. K. H. Kam.  
1986. Fatal shark attack on a Hawaiian monk seal (*Monachus schauinslandi*). Mar. Mammal Sci. 2(4):313-315.
- Amerson, A. B., Jr.  
1971. The natural history of French Frigate Shoals Northwestern Hawaiian Islands. Atoll Res. Bull. 150, 383 p.
- Balazs, G. H., and G. C. Whittow.  
1979. First record of a tiger shark observed feeding on a Hawaiian monk seal. 'Elepaio 39(9):107-109.
- Boness, D. J.  
1990. Fostering behavior in Hawaiian monk seals: Is there a reproductive cost? Behav. Ecol. Sociobiol. 27:113-122.

DeLong, R. L., and R. L. Brownell, Jr.

1977. Hawaiian monk seal (*Monachus schauinslandi*) habitat and population survey in the northwestern (leeward) Hawaiian Islands, April 1977. Northwest & Alaska Fish. Cent. Processed Rep., 43 p.

Fiscus, C. H., A. M. Johnson, and K. W. Kenyon.

1978. Hawaiian monk seal (*Monachus schauinslandi*) survey of the Northwestern (leeward) Hawaiian Islands, July 1978. Northwest & Alaska Fish. Cent. Processed Rep., 27 p.

Gilmartin, W. G.

1983. Recovery plan for the Hawaiian monk seal, *Monachus schauinslandi*. U.S. Dep. Commerce, NOAA, Natl. Mar. Fish. Serv., Southwest Region, 300 South Ferry St., Room 20216. Terminal Island, CA 90731, 44 p.

Henderson, J. R.

1985. A review of Hawaiian monk seal entanglements in marine debris. In Shomura, R. S. and H. O. Yoshida (editors), Proceedings of the Workshop on the Fate and Impact of Marine Debris, 27-29 November 1984, Honolulu, Hawaii, p. 326-335. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-54.

Johanos, T. C., and S. L. Austin.

1988. Hawaiian monk seal population structure, reproduction, and survival on Laysan Island, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-118, 38 p.

Johanos, T. C., and A. K. H. Kam.

1986. The Hawaiian monk seal on Lisianski Island: 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-58, 37 p.

Johanos, T. C., A. K. H. Kam, and R. G. Forsyth.

1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-70, 38 p.

Johnson, B. W., and P. A. Johnson.

1978. The Hawaiian monk seal on Laysan Island: 1977. U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA. PB-285-428, 38 p.

1981. The Hawaiian monk seal on Laysan Island: 1978. U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA. PB-82-109661, 17 p.

1984. Hawaiian monk seal observations on French Frigate Shoals, 1980. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-50, 47 p.

Kenyon, K. W.

1966. Marine wildlife biological observations in the leeward Hawaiian islands 8-27 September 1966. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Sand Point Naval Air Station, Seattle, Washington 98115. Unpubl. rep., 47 p.

1972. Man versus the monk seal. J. Mammal. 53:687-696.

Rauzon, M. J., K. W. Kenyon, and A. M. Johnson.

1978. Observations of monk seals, French Frigate Shoals 17 February to 27 May 1977, U.S. Fish and Wildlife Service, National Fish and Wildlife Laboratory, Anchorage Field Station, 4454 Business Park Blvd., Anchorage, Alaska 99503. Unpubl. rep., 34 p.

Reddy, M. L., and C. A. Griffith.

1988. Hawaiian monk seal population monitoring, pup captive maintenance program, and incidental observations of the green turtle at Kure Atoll, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-101, 35 p.

Schulmeister, S.

1981. Hawaiian monk seal numbers increase on Tern Island. 'Elepaio 41(7):62-63.

Stone, H. S.

1984. Hawaiian monk seal population research, Lisianski Island, 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-47, 33 p.

Taylor, L. R., and G. Naftel.

1978. Preliminary investigations of shark predation on the Hawaiian monk seal at Pearl and Hermes Reef and French Frigate Shoals. U.S. Dep. Commer. Natl. Tech. Inf. Serv. PB-285-626, 34 p.

Westlake, R. L., and W. G. Gilmartin.

1990. Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands. Pac. Sci. 44:366-383.

Wirtz, W. O. II.

1968. Reproduction, growth and development, and juvenile mortality in the Hawaiian monk seal. J. Mammal. 49:229-238.

# TABLES



Table 1.--Summary of census counts of Hawaiian monk seals at French Frigate Shoals, 1984.

Island	Entire year			March-September		
	No. counts	Mean	SD	No. counts	Mean	SD
Bare	13	2.3	2.3	8	3.5	2.1
Disappearing <sup>a</sup>	10	31.9	19.2	4	16.3	17.6
East	61	29.9	16.6	39	38.0	15.3
Gin	31	9.7	5.5	18	11.2	5.7
Little Gin	31	11.5	6.4	19	13.5	7.2
Mullet <sup>b</sup>	14	2.9	2.7	7	4.3	3.0
Round	43	11.6	7.9	34	14.0	7.1
Shark	10	15.1	7.5	4	9.3	6.7
Tern	109	59.7	20.1	60	52.0	14.5
Trig	51	22.4	10.6	29	14.4	8.8
Whale-Skate	62	43.4	14.9	37	40.5	23.3
Sand spit east of East Island	1	5.0	0.0	1	5.0	0.0

<sup>a</sup>Island awash on 26 June and 7 July with little or no area for hauling out. If counts on those dates are disregarded, the mean for the entire year is 39.5 (SD = 12.0), and the March-September mean is 31.0 (SD = 7.1).

<sup>b</sup>Island awash on 30 March and 10 April with little or no area for hauling out. If counts on those dates are disregarded, the mean for the entire year is 3.3 (SD = 2.6), and the mean for March-September is 6.0 (SD = 1.0).

Table 2.--Summary of Hawaiian monk seal pups tagged at French Frigate Shoals, 1984.

ID No.	Tag No.		Sex <sup>a</sup>	Date tagged	Measurement (cm) <sup>b</sup>		Birth date	Birth island <sup>c</sup>	Weaning date	Mother ID <sup>d</sup>	Days nursing
	Left	Right			AG	SL					
Y289	T00	T00	M	3/30	105.0	131.0	--	LG	--	--	--
Y290 <sup>e</sup>	T01	T01	F	5/29	88.0	116.0	3/21-25	WS	4/26-5/1	Y229	32-41
Y291 <sup>e</sup>	T02	T02	M	5/29	83.5	112.0	4/26-5/1	WS	5/23-29	P-W-13	22-33
Y292	T03	T03	M	5/29	97.5	122.5	--	WS	--	--	--
Y293	T04	T04	M	5/29	85.0	112.0	--	WS	--	--	--
Y294 <sup>e</sup>	T05	T05	M	5/30	79.0	108.0	--	EA	--	--	--
Y295	T06	T06	M	5/30	106.0	116.0	--	EA	--	--	--
Y296	T07	T07	M	5/30	100.0	120.0	--	EA	--	--	--
Y297	T08	T08	M	5/30	81.0	103.0	--	EA	--	--	--
Y298	T199	T09	M	5/30	135.5	138.0	--	EA	--	--	--
Y299 <sup>e</sup>	T10	T10	F	5/30	94.0	117.0	--	EA	--	--	--
Y300	T11	T11	M	5/30	100.5	128.0	--	EA	--	--	--
Y301	T12	T12	M	5/30	113.0	130.0	--	EA	--	--	--
Y302	T13	T13	M	6/4	116.5	132.0	--	EA	--	--	--
Y303	T14	T14	F	6/4	113.0	133.0	--	EA	--	--	--
Y304	T15	T15	M	6/5	86.0	119.0	--	EA	--	--	--
Y305	T16	T16	F	6/5	104.0	142.0	3/11-4/11	EA	5/13-20	P-E-23	32-70
Y306	T17	T17	M	6/6	90.5	122	--	EA	--	--	--
Y307	T18	T18	F	6/7	111.0	127.0	4/18-20	EA	6/7	Y010	46-48
Y308	T19	T19	F	6/9	93.0	128.5	--	LG	--	--	--
Y309	T20	T20	F	6/9	94.0	126.5	--	GI	--	--	--
Y310	T21	T21	F	6/10	107.5	137.0	4/26	EA	6/7	Y251	42
Y311	T22	T22	F	6/10	90.0	118.5	5/4-6	EA	6/7	Y173	32-34
Y312	T23	T23	F	6/12	125.0	132.0	--	EA	--	--	--
Y313	T24	T24	F	6/15	74.0	110.0	--	EA	--	--	--
Y314	T25	T25	M	6/15	113.0	128.0	--	EA	--	--	--
Y315	T26	T26	F	6/18	113.0	126.0	--	EA	--	--	--
Y316	T27	T27	M	6/20	112.5	134.0	5/4-6	EA	6/19	Y014	44-46
Y317	T28	T28	M	6/22	115.0	135.5	--	EA	--	--	--

Table 2.--Continued.

ID No.	Tag No.		Sex <sup>a</sup>	Date tagged	Measurement (cm) <sup>b</sup>		Birth date	Birth island <sup>c</sup>	Weaning date	Mother ID <sup>d</sup>	Days nursing
	Left	Right			AG	SL					
Y318	T29	T29	F	6/22	96.0	131.5	--	EA	--	--	--
Y319 <sup>e</sup>	T30	T30	F	6/23	89.5	122.5	5/11-19	WS	6/21	P-W-14	33-41
Y320	T31	T31	M	6/26	101.0	121.0	--	LG	--	--	--
Y321	T32	T32	M	6/27	113.5	130.0	--	EA	--	--	--
Y322	T33	T33	M	6/28	103.0	123.0	5/23-29	WS	6/28	P-W-16	30-36
Y323 <sup>f</sup>	T34	T34	F	6/28	91.5	125.0	5/23-29	WS	6/22-24	--	24-32
Y324 <sup>e</sup>	T35	T35	F	6/28	73.0	113.0	5/20-29	TR	6/19-28	Y462	21-39
Y325	T36	T36	M	7/5	121.5	130.0	5/20-22	WS	6/29-7/5	Y463	38-46
Y326 <sup>g</sup>	T37	T37	M	7/5	116.0	133.0	5/11-19	WS	6/29-7/5	--	41-55
Y327	T38	T38	F	7/5	105.0	128.0	5/23-29	WS	6/29-7/5	Y190	31-43
Y328	T39	T39	F	7/7	110.0	134.0	--	EA	--	--	--
Y329	T40	T40	F	7/7	106.0	125.0	--	EA	--	--	--
Y330	T41	T41	M	7/7	110.0	130.0	--	EA	--	--	--
Y331	T42	T42	M	7/7	113.5	133.0	--	EA	--	--	--
Y332 <sup>h</sup>	T43	T43	M	7/7	103.5	120.0	--	EA	--	--	--
Y333	T44	T44	F	7/9	96.0	139.0	--	RO	--	--	--
Y334	T45	T45	F	7/11	81.0	121.0	--	RO	--	--	--
Y335 <sup>i</sup>	T46	T46	F	7/12	118.0	132.0	6/4-8	WS	7/12	Y570	34-38
Y336	T47	T47	M	7/14	92.0	113.0	5/12-6/9	LG	7/8-14	Y468	29-63
Y337	T48	T48	F	7/14	110.0	125.0	--	EA	--	--	--
Y338	T49	T49	M	7/18	102.0	124.0	6/4-8	WS	7/14-18	Y227	36-44
Y339	T50	T50	M	7/18	99.0	112.0	6/13	WS	7/14-18	Y465	31-35
Y340	T51	T51	M	7/20	98.0	119.0	--	EA	--	--	--
Y341	T52	T52	M	7/20	96.5	122.0	--	EA	--	--	--
Y342	T86	T53	F	7/29	101.0	134.0	6/15	EA	7/23-26	Y029	38-41
Y343	T54	T54	F	7/30	115.5	135.0	--	WS	--	--	--
Y344	T55	T55	F	7/30	94.0	117.0	--	WS	--	--	--
Y345	T56	T56	M	7/30	92.0	116.0	6/22-24	WS	7/21-26	Y563	27-34
Y346 <sup>e</sup>	T57	T57	M	7/31	60.0	101.0	--	RO	--	--	--

Table 2.--Continued.

ID No.	Tag No.		Sex <sup>a</sup>	Date tagged	Measurement (cm) <sup>b</sup>		Birth date	Birth island <sup>c</sup>	Weaning date	Mother ID <sup>d</sup>	Days nursing
	Left	Right			AG	SL					
Y347	T59	T59	F	8/4	101.0	143.0	--	RO	--	--	--
Y348	T60	T60	F	8/4	109.0	146.0	--	EA	--	--	--
Y349	T61	T61	M	8/4	67.0	113.0	--	RO	--	--	--
Y350	T62	T62	M	8/17	104.0	127.0	--	WS	--	--	--
Y351	T63	T63	F	8/17	103.5	139.0	7/5	WS	8/9-17	Y150	35-43
Y352	T64	T64	M	8/17	106.0	137.0	--	WS	--	--	--
Y353	T65	T65	F	8/17	102.0	137.0	--	RO	--	--	--
Y354	T66	T66	F	8/7	101.0	140.0	6/29-7/7	EA	8/3-4	Y201	27-36
Y355	T67	T67	F	8/8	125.0	140.0	6/10-26	GI	7/29-8/8	Y466	33-59
Y356	T68	T68	M	8/8	97.0	143.0	--	RO	--	--	--
Y357	T69	T69	M	8/8	110.0	140.0	--	EA	--	--	--
Y358	T70	T70	M	8/9	111.0	134.0	6/29-7/7	EA	8/9	Y218	33-41
Y359	T71	T71	M	8/21	89.0	126.0	--	RO	--	--	--
Y360	T72	T72	M	8/21	100.0	120.0	6/27	WS	8/9-17	Y566	43-51
Y361	T73	T73	M	8/21	110.0	115.0	7/14-15	WS	8/18-20	Y288	34-37
Y362	T74	T74	M	8/23	91.0	126.0	--	RO	--	--	--
Y363	T75	T75	M	8/23	96.0	123.0	--	RO	--	--	--
Y364	T76	T76	M	8/23	93.5	126.0	--	RO	--	--	--
Y365	T77	T77	F	8/23	96.0	127.0	--	RO	--	--	--
Y366	T78	T78	F	8/23	120.0	140.0	--	WS	--	--	--
Y367	T79	T79	F	8/25	96.0	132.0	--	RO	--	--	--
Y368	T80	T80	M	8/28	95.5	127.0	--	RO	--	--	--
Y369	T81	T81	F	8/28	107.0	128.0	--	RO	--	--	--
Y370	T82	T82	M	8/28	85.0	120.0	--	RO	--	--	--
Y371	T83	T83	F	8/28	110.0	136.0	--	RO	--	--	--
Y372	T84	T84	M	8/28	116.5	129.0	--	RO	--	--	--
Y373	T85	T85	F	8/30	99.0	123.0	7/28	EA	8/29-30	Y564	32-33
Y374 <sup>j</sup>	T87	T87	F	--	--	--	--	--	--	--	--
Y375	T88	T88	M	10/16	97.0	133.0	--	WS	--	--	--

Table 2.--Continued.

ID No.	Tag No.		Sex <sup>a</sup>	Date tagged	Measurement (cm) <sup>b</sup>		Birth date	Birth island <sup>c</sup>	Weaning date	Mother ID <sup>d</sup>	Days nursing
	Left	Right			AG	SL					
Y376	T89	T89	M	10/16	85.0	127.0	--	WS	--	--	--
Y377	T90	T90	F	10/17	124.0	135.0	--	WS	--	--	--
Y378	T95	T95	F	10/17	105.0	131.0	--	EA	--	--	--
Y379	T96	T96	F	10/16	115.0	143.0	--	RO	--	--	--
Y380	T99	T99	M	10/17	114.0	128.0	--	EA	--	--	--

<sup>a</sup>M = male; F = female.<sup>b</sup>AG = axillary girth; SL = straight length, nose to tip of tail, measured dorsally.<sup>c</sup>EA = East Island, GI = Gin Island, LG = Little Gin Island, RO = Round Island, TR = Trig Island, and WS = Whale-Skate Island.<sup>d</sup>Mother ID is included only if no pup exchanges were noted.<sup>e</sup>Pup collected and brought to Honolulu for rehabilitation.<sup>f</sup>Pup was born to female Y464 and weaned from female Y011.<sup>g</sup>Pup was born to female Y011 and weaned from female Y464.<sup>h</sup>Pup was weaned and tagged on 7 July. It nursed from a foster female for another 2 days (13-14 July).<sup>i</sup>After the pup was tagged, it nursed for an additional 31-40 days from another female.<sup>j</sup>Tagging information lost.

Table 3.--Identified female Hawaiian monk seals parturient at French Frigate Shoals, 1984.

ID No.	Temp. ID	Island <sup>a</sup>	Date pupped <sup>b</sup>	Date of weaning <sup>c</sup>	Pup ID <sup>d</sup>	Sex of pup <sup>e</sup>	Comments
Y004	E50	EA	8/4	>8/30	U	U	
Y009 <sup>f</sup>	E46	EA	6/28	8/5-6	U	F	Pup exchange
Y010 <sup>f</sup>	--	EA	4/18-20	6/5	Y307	F	
Y011	W7	WS	5/11-19	6/22-24	U	M	Pup exchange
Y014 <sup>f</sup>	E23	EA	5/4-6	6/19	Y316	M	
Y029 <sup>f</sup>	--	EA	6/15	7/23-26	Y342	F	
Y046 <sup>f</sup>	--	EA	5/8-11	6/15	U	M	Pup exchange
Y056 <sup>f</sup>	E41	EA	6/6	7/16-20	U	M	
Y059 <sup>f</sup>	W24	WS	7/18	8/18-21	U	F	
Y063 <sup>f</sup>	--	EA	4/11	5/22	U	M	Pup exchange
Y094	W16	WS	6/9	7/21-26	U	F	
Y103	W3	WS	3/31-4/10	5/11-19	U	M	
Y110	--	TE	5/2-3	--	U	F	Pup stillborn
Y128	E15	EA	4/18-20	5/23-29	U	F	
Y144	W5	WS	<3/25	--	U	M	Perinatal death
Y145	R2	RO	<3/10	Unknown	U	U	
Y150	--	WS	7/5	8/9-17	Y351	F	
Y156	P43	EA	3/17-23	4-28-5/2	U	M	
Y159 <sup>f</sup>	W21	WS	6/28	8/5-6	U	U	Pup exchange
Y164	R3	RO	3/31-4/10	Unknown	U	U	
Y173 <sup>f</sup>	E24	EA	5/4-6	6/7	Y311	F	
Y185	R6	RO	4/25-5/1	Unknown	U	U	
Y190	--	WS	5/23-29	6/29-7/5	Y327	F	
Y199	W26	WS	7/21-26	>8/30	U	M	
Y201	E47	EA	6/29-7/7	8/3-4	Y354	F	
Y203 <sup>f</sup>	E43	EA	6/10	7/14	U	U	Pup exchange
Y206	W2	WS	3/31-4/10	Unknown	U	U	Pup disappeared
Y209	E28	EA	5/20	6/28-7/7	U	U	Pup exchange
Y217	LG2	LG	4/17-21	5/12-6/9	U	U	
Y218	E48	EA	6/29-7/7	8/9	Y358	M	
Y224 <sup>f</sup>	E18;PE9	EA	4/18-20	6/1-3	U	U	Pup exchange
Y227	W15	WS	6/4-8	7/14-18	Y338	M	
Y229	W1	WS	3/21-25	4/26-5/1	Y290	F	Pup flown to Honolulu
Y233	E33	EA	5/22	6/28-7/7	U	M	
Y237	W4	WS	4/21-25	5/20-22	U	M	
Y251 <sup>f</sup>	E16	EA	4/26	6/7	Y310	F	
Y253 <sup>f</sup>	E7	EA	4/12-14	5/21	U	M	
Y262 <sup>f</sup>	E45	EA	6/27	8/3	U	U	Pup exchange
Y266	E12;E17	EA	4/22-26	5/31-6/4	U	U	
Y271	E51	EA	8/7	>8/30	U	F	
Y273	W27	WS	8/5-6	>8/30	U	M	
Y283	E26	EA	5/13-20	6/28-7/7	U	U	Pup exchange
Y286	E44	EA	6/26	Unknown	U	U	Pup disappeared
Y287	E29	EA	5/13-20	6/16-18	U	U	Pup exchange
Y288 <sup>f</sup>	W25	WS	7/14-15	8/18-20	Y361	M	
Y457 <sup>f</sup>	PE1	EA	5/4-6	6/7	U	U	Pup exchange

Table 3.--Continued.

ID No.	Temp. ID	Island <sup>a</sup>	Date pupped <sup>b</sup>	Date of weaning <sup>c</sup>	Pup ID <sup>d</sup>	Sex of pup <sup>e</sup>	Comments
Y459	E36;PE6	EA	5/23-29	6/28-7/7	U	U	Pup exchange
Y460 <sup>f</sup>	E25;PE11	EA	5/7	6/15	U	U	Pup exchange
Y461	E8;PE26	EA	4/15-16	--	U	U	Perinatal death
Y462	T1;PT1	TR	5/20-29	6/19-28	Y324	F	Pup flown to Honolulu
Y463	W10;PW15	WS	5/20-22	6/29-7/5	Y325	M	
Y464	W13;PW17	WS	5/23-29	6/29-7/5	U	U	Pup exchange
Y465 <sup>f</sup>	W17;PW4	WS	6/13	7/14-18	Y339	M	
Y466	G1;PG1	GI	6/10-26	7/29-8/8	Y355	F	
Y467	R12;PR13	RO	8/1	Unknown	U	U	
Y468	LG4;PLG3	LG	5/12-6/9	7/8-14	Y336	M	
Y501	E38;PE8	EA	5/30	6/28-7/7	U	M	
Y529	E40;PE10	EA	6/5	7/15-20	U	U	Pup exchange
Y534	E6;PE25	EA	3/31-4/11	5/21	U	M	
Y542	E5;PE24	EA	3/31-4/11	5/13-20	U	M	
Y552	PW21	WS	6/29-7/5	8/8	U	M	
Y553 <sup>f</sup>	E20;PE28	EA	5/6	6/12	U	U	Pup exchange
Y563	W19;PW20	WS	6/22-24	7/21-26	Y345	M	
Y564 <sup>f</sup>	E49;PE18	EA	7/28	8/29-30	Y373	F	
Y565 <sup>f</sup>	E34;PE30	EA	5/22	6/25	U	U	Pup exchange
Y566	W20;PW5	WS	7/13	8/9-17	Y360	M	Pup stillborn; mother adopted pup Y335 for full nursing period
Y568	W23;PW10	WS	7/13	8/18-23	U	U	
Y569	W29;PW12	WS	8/23-30	>8/30	U	U	
Y570 <sup>f</sup>	W14;PW18	WS	6/4-8	7/12	Y335	F	
Y571	LG1;PLG1	LG	<3/12	3/31-4/11	U	F	
--	PE21	EA	2/27-3/1	4/15-17	U	M	
--	PE22	EA	2/27-3/1	4/15-17	U	M	
--	PE23	EA	3/31-4/11	5/13-20	Y305	F	
--	PE27	EA	4/18-20	5/22-31	U	M	
--	PE29 <sup>f</sup>	EA	5/4-6	6/22	U	U	Pup exchange
--	PE31	EA	--	6/22	U	U	Pup exchange
--	PLG2	LG	4/22-26	5/12-6/9	U	U	
--	PW13	WS	4/26-5/1	5/23-29	Y291	M	Pup flown to Honolulu
--	PW14	WS	5/11-19	6/21	Y319	F	Pup flown to Honolulu
--	PW16	WS	5/23-29	6/28	Y322	M	
--	PW19	WS	6/15-18	7/21-26	U	F	

<sup>a</sup>EA = East Island, GI = Gin Island, LG = Little Gin Island, RO = Round Island, TE = Tern Island, TR = Trig Island, and WS = Whale-Skate Island.

<sup>b</sup>Date is first day an adult female was seen with a pup; if interval is given, dates are the day after the female was last seen without pup and first day she was seen with pup.

Table 3.--Continued.

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<sup>c</sup>Date is the first day an adult female was seen without a pup; if interval is given, dates are the day after the female was last seen with a pup and first day she was seen without a pup.

<sup>d</sup>A pup's ID number is included only when no pup exchange has been noted.

<sup>e</sup>M = male, F = female, and U = unknown sex.

<sup>f</sup>Lactation period is known within 5 days; midpoint of range is used to calculate mean lactation period.



Table 4.--Observations of interatoll movement to and from French Frigate Shoals (FFS) by Hawaiian monk seals in 1984.

ID No.	Bleach No.	Size <sup>a</sup>	Sex <sup>b</sup>	Movement from		Movement to		Comments
				Location <sup>c</sup>	Date last seen	Location <sup>c</sup>	Date first seen	
R201	201	A	M	Necker <sup>d</sup>	8/3/83	FFS, DI	1/6/84	
R217	217	A	F	Necker <sup>d</sup>	8/5/83	FFS, EA	12/27/83	
GS33	S33	S	M	FFS, EA	1/21/84	Necker <sup>d</sup>	6/20/84	
				Laysan <sup>e</sup>	7/6/83	FFS, TE	1/1/84	At FFS in October 1983 <sup>f</sup>
Y156	P43	A	F	FFS, TE	1/4/84	Laysan <sup>f</sup>	4/18/84	
				Laysan <sup>e</sup>	6/27/83	FFS, EA	3/16/84	Molted on Laysan in 1983
--	XO	J	M	FFS, EA	4/28/84	Laysan <sup>d</sup>	6/13/84	Pupped at FFS in March 1984
--	BY	J	F	FFS, TE	5/1/84	Necker <sup>d</sup>	6/20/84	
--	GF	J	M	FFS, EA	12/28/83	Necker <sup>d</sup>	6/20/84	
--	BE	J	F	FFS, EA	8/30/83	Necker <sup>d</sup>	6/20/84	
TP77	Y63	S	M	FFS, EA	12/30/83	Necker <sup>d</sup>	8/10/84	
				Lisianski <sup>g</sup>	8/1/83	FFS, TE	8/21/84	

<sup>a</sup>A = adult, J = juvenile, and S = subadult.

<sup>b</sup>M = male; F = female.

<sup>c</sup>DI = Disappearing Island, EA = East Island, and TE = Tern Island.

<sup>d</sup>NMFS (unpubl. data).

<sup>e</sup>Alcorn and Buelna (1989).

<sup>f</sup>G. Fairaizl, U.S. Fish and Wildlife Service, P.O. Box 50167, Honolulu, HI 96850, pers. commun., March 1984.

<sup>g</sup>Johanos et al. (1987).

Table 5.--Injuries of Hawaiian monk seals observed at French Frigate Shoals, 1984.

Date	Seal ID	Size <sup>a</sup>	Sex <sup>b</sup>	Island <sup>c</sup>	Injury location	Description of injury	Probable cause
4/9	--	S	M	TE	Not noted	Open gaping wound	Unknown
4/14	--	J	M	EA	Postero-dorsal	Abrasion	Unknown
4/30	Y131	A	M	TE	Lateral	Deep gaping wound, 30 cm x 25 cm <sup>d</sup>	Shark
6/1	--	S	M	WS	Rt. Postero-lateral	Deep gaping wound, 25 cm dia <sup>d</sup>	Shark
6/20	Y184	A	M	WS	Rt. Postero-lateral	Open gaping wound	Shark
6/27	--	A	F	WS	Foreflipper	Laceration to muscle, 5 cm long	Unknown
7/7	--	W	F	LG	Postero-dorsal	Small abscess	Seal
7/13	--	A	F	EA	Dorsal	Abscess, 7-8 cm dia	Seal
7/18	--	W	M	WS	Dorso-lateral	Abscess, 12 cm dia	Seal
7/21	--	J	F	EA	Hind flipper	Laceration	Unknown
7/27	--	J	M	WS	Ventral	Bleeding abscess, 8 x 3 cm	Unknown
7/29	--	S	F	WS	Hind flipper	Distal lobe severed	Shark
8/4	--	W	F	EA	Hind flipper	Proximal lobe severed	Shark
8/6	--	A	U	WS	Postero-dorsal	Gaping wound, 15 x 10 x 5 cm <sup>d</sup>	Seal
8/20	--	W	F	EA	Muzzle	Laceration, 5 cm long	Unknown
8/20	--	A	F	EA	Dorsal	Gaping wound <sup>d</sup>	Seal
8/28	--	S	F	EA	Dorsal	Gaping wound <sup>d</sup>	Seal
8/30	--	W	U	WS	Postero-dorsal	Abscess, 6-7 cm dia	Seal

<sup>a</sup>A = adult, J = juvenile, S = subadult, and W = weaned pup.<sup>b</sup>M = male, F = female, and U = unknown sex.<sup>c</sup>EA = East Island, LG = Little Gin Island, TE = Tern Island and WS = Whale-Skate Island.<sup>d</sup>Severe wound.

Table 6.--Hawaiian monk seal entanglements in debris at French Frigate Shoals, 1984.

No.	Date	Island	Size <sup>a</sup>	Sex <sup>b</sup>	ID/bleach No.	Type of debris	Body part entangled
1	6 Jun	Tern	S	U	--	Plastic ring	Neck
2	9 Jun	Gin	J	M	GA	Fishing net	Neck and axilla

<sup>a</sup>J = juvenile; S = subadult.

<sup>b</sup>M = male; U = unknown sex.

Table 7.--Hawaiian monk seal deaths and disappearances recorded at French Frigate Shoals, 1984.

Case No.	Date noted	Island <sup>a</sup>	Size <sup>b</sup>	Sex <sup>c</sup>	ID/bleach No.	Cause of death
1	26 Feb	TR	N	M?	--	Stillborn
2	16 Mar	RO	PW	U	--	Disappeared
3	25 Mar	WS	N	M	--	Stillborn?
4	12 Apr	TE	J	F	EV	Starvation
5	16 Apr	EA	N	U	--	Stillborn
6	3 May	TE	N	F	--	Stillborn
7	19 May	WS	J	F	--	Unknown
8	22 May	WS	N	U	--	Disappeared <2 wk post-birth
9	20 Jun	EA	PW	F	Y313	Disappeared
10	27 Jun	EA	N	U	--	Disappeared <1 day post-birth
11	13 Jul	WS	N	M	--	Stillborn
12	4 Aug	WS	A	M	--	Unknown

<sup>a</sup>EA = East Island, RO = Round Island, TE = Tern Island, TR = Trig Island, and WS = Whale-Skate Island.

<sup>b</sup>A = adult, J = juvenile, N = neonate, and PW = prematurely weaned pup.

<sup>c</sup>M = male, F = female, and U = unknown sex.

# FIGURES

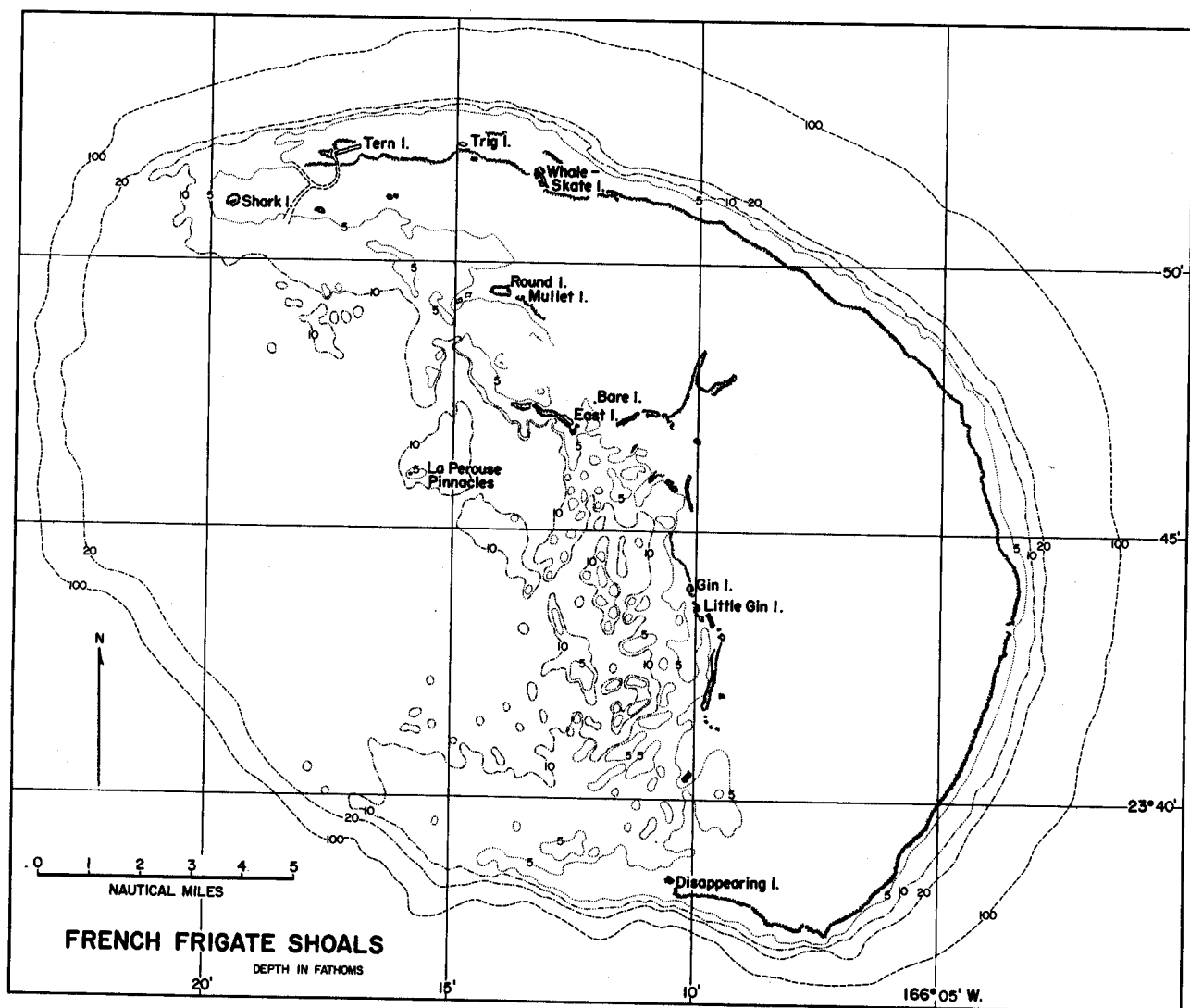


Figure 1.--French Frigate Shoals showing the 12 islands present in 1984.

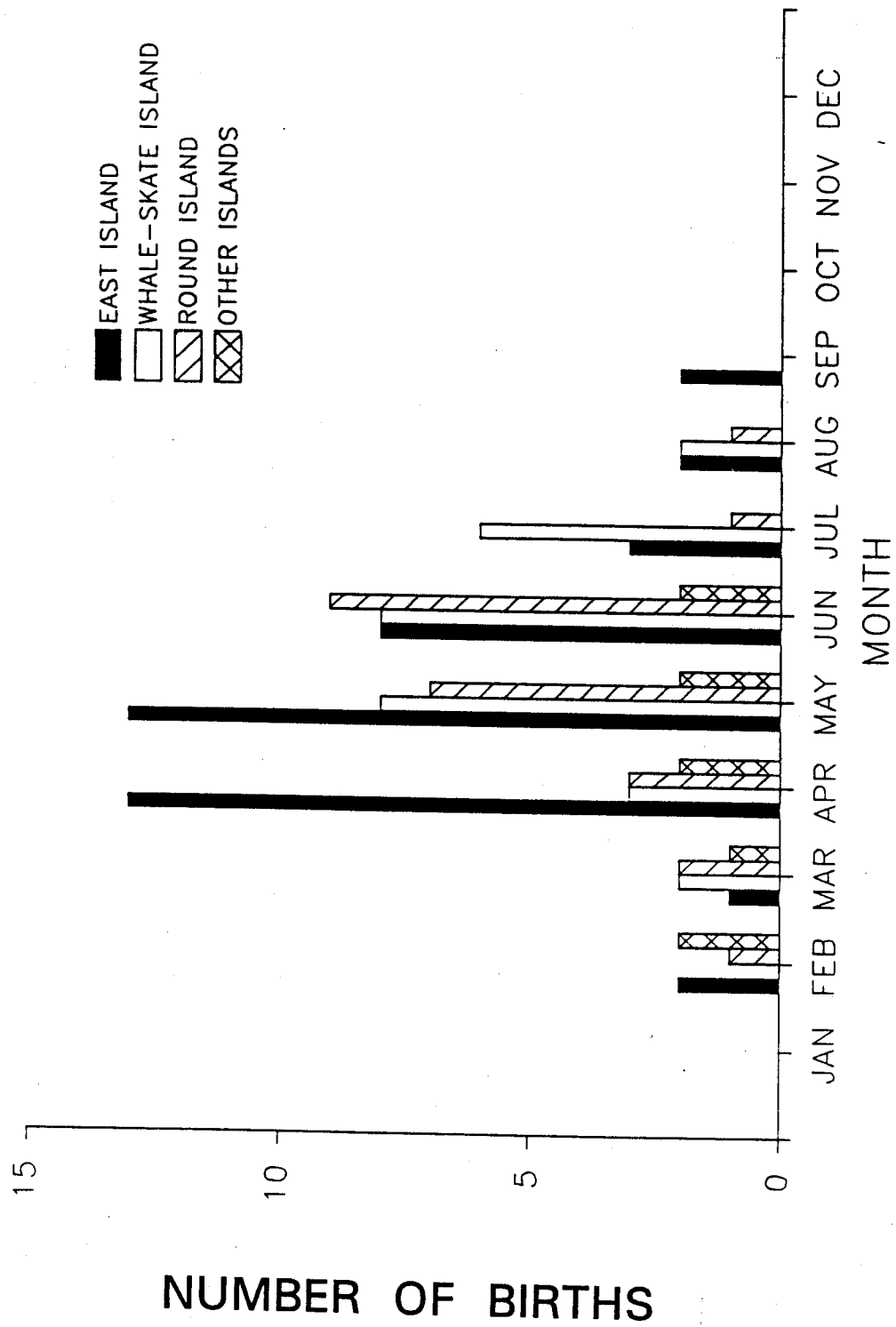


Figure 2.--Number of pups born each month on each island at French Frigate Shoals, 1984. Totals include stillborn pups.



(A)



(B)



(C)

Figure 3.--Adult male Y131. (A) 30 April 1984 with fresh shark-inflicted wound. (B) 13 June 1984 with healing wound. (C) 10 August 1984 with healed wound.



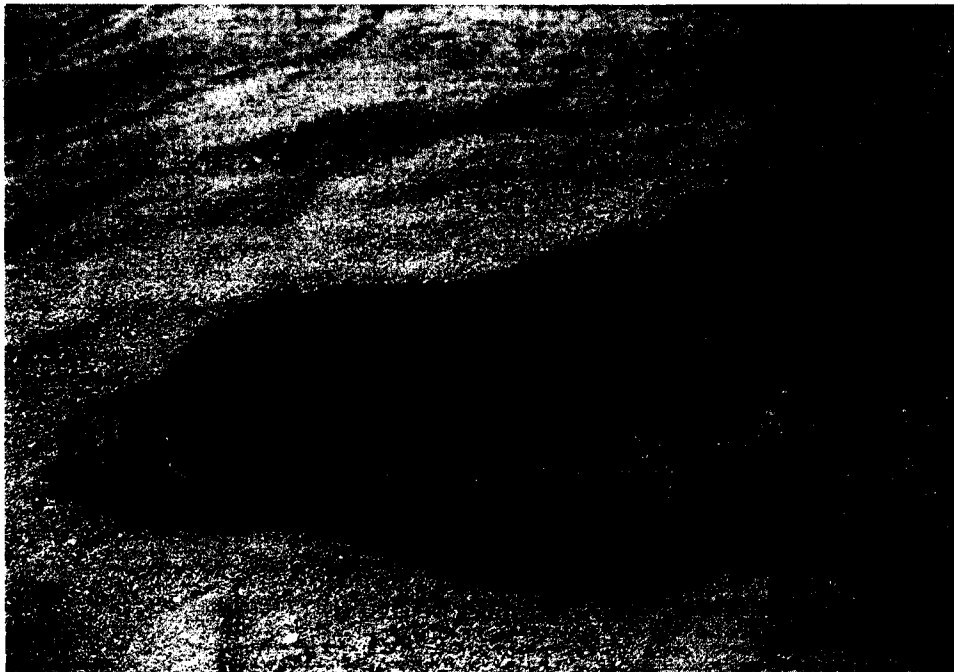


Figure 4.--Subadult seal of unknown sex entangled by rim of plastic bucket, French Frigate Shoals, 1984.



Figure 5.--Recently weaned pup with face covered by holothurian viscera, French Frigate Shoals, 1984.

# APPENDIXES

Appendix A.--Itinerary for field program at French Frigate Shoals, 1984.

Date	Event
<b>1983</b>	
26 December	W. Gilmartin, J. Henderson, S. Lautenslager, and A. Kam arrive via charter flight.
27 December	Temporary field camps established on East and Whale-Skate Islands.
<b>1984</b>	
24 January	Temporary camps disbanded.
27 January	Gilmartin, Henderson, Lautenslager, and Kam depart via charter flight.
7 March	J. Eliason and Kam arrive via charter flight.
27 March	R. Forsyth arrives via the fishing vessel <i>Feresa</i> .
2 April	Forsyth and Kam depart via the fishing vessel <i>Day Star</i> .
8 April	G. Barone arrives via the fishing vessel <i>Feresa</i> .
14 April	Temporary field camp established on East Island.
25 May	Gilmartin arrives and Barone departs via charter flight.
2 June	G. Balazs, Henderson, and Lautenslager arrive via charter flight.
3 June	Gilmartin departs via charter flight.
8 June	Temporary field camp established on Whale-Skate Island.
17 June	Balazs departs via charter flight.
4 July	Lautenslager departs via charter flight.
25 July	G. Peiterson, R. Westlake, and S. White arrive and Henderson departs via charter flight.

## Appendix A.--Continued.

Date	Event
9 August	R. Morrow arrives via the NOAA ship <i>Townsend Cromwell</i> .
12 August	Peiterson, Westlake, and White depart via charter flight.
23 August	Camp on Whale-Skate Island is disbanded.
28 August	Camp on East Island is disbanded.
31 August	Eliason and Morrow depart via charter flight; NMFS summer field effort terminated.
16 October	Gilmartin, T. Johanos, Kam, S. Minasian, and Morrow arrive via charter flight to tag remaining weaned pups.
20 October	Gilmartin, Johanos, Kam, Minasian, and Morrow depart via the <i>Townsend Cromwell</i> ; NMFS field effort terminated.

Appendix B.--Summary of atoll-wide counts of Hawaiian monk seals at French Frigate Shoals, 1984 (M = male, F = female, and U = unknown sex).

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
1/ 6	31	24	42	13	7	22	21	20	14	0	0	0	194	0	194
1/11	32	18	29	11	13	14	19	20	27	0	0	0	203 <sup>a</sup>	0	203
1/15	34	32	35	15	6	26	18	29	36	0	0	0	231	0	231
1/20	38	43	52	15	12	33	22	22	19	0	0	0	256	0	256
Mean	33.8	29.3	39.5	13.5	9.5	23.8	20.0	22.8	24.0	0	0	0	221.0	0	221.0

<sup>a</sup>Total includes some seals which were not placed in any size class.

Appendix C.--Summary of census counts of Hawaiian monk seals at French Frigate Shoals, 1984 (M = male, F = female, and U = unknown sex).

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Bare Island</b>															
1/ 7	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
1/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/15	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
1/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/23	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
4/17	0	0	1	0	0	1	0	0	0	0	0	0	2	0	2
4/21	0	1	1	0	0	2	0	0	2	0	0	0	6	0	6
5/ 6	0	0	4	0	0	1	0	0	0	0	0	0	5	0	5
5/22	0	0	0	0	0	1	0	0	2	0	0	0	3	0	3
7/15	0	0	1	0	0	0	1	0	1	0	1	0	3	1	4
7/30	0	0	1	0	0	1	0	0	3	0	0	1	5	1	6
9/21	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
Mean	0	0.2	0.8	0.0	0.0	0.5	0.1	0.0	0.6	0.0	0.1	0.1	2.2	0.2	2.3
<b>Disappearing Island</b>															
1/ 7	5	1	10	4	0	7	2	2	3	0	0	0	34	0	34
1/10	5	2	1	2	0	8	6	0	9	0	0	0	33	0	33
1/11	4	0	4	4	0	5	6	1	17	0	0	0	41	0	41
1/14	4	3	19	1	2	16	3	4	12	0	0	0	64	0	64
1/15	3	1	14	0	1	13	5	1	11	0	0	0	49	0	49
1/20	2	2	13	0	2	5	4	0	5	0	0	0	33	0	33
3/16	0	0	3	1	3	15	3	4	7	0	0	0	36	0	36
6/ 9	0	2	5	0	0	3	6	3	7	0	0	0	26	0	26
6/26 <sup>a</sup>	0	0	1	0	0	2	0	0	0	0	0	0	3	0	3
7/ 7 <sup>a</sup>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	2.3	1.1	7.0	1.2	0.8	7.4	3.5	1.5	7.1	0	0	0	31.9	0	31.9
<b>East Island</b>															
1/ 2	2	2	3	0	0	2	4	7	3	0	0	0	23	0	23
1/ 3	0	2	2	0	0	1	0	4	1	0	0	0	10	0	10
1/ 4	1	2	0	1	0	1	4	4	5	0	0	0	18	0	18
1/ 5	1	3	0	0	0	1	1	6	2	0	0	0	14	0	14
1/ 6	0	1	3	1	2	0	2	4	3	0	0	0	16	0	16
1/ 7	2	3	0	0	0	0	2	3	0	0	0	0	10	0	10
1/ 8	0	3	2	0	1	3	2	1	3	0	0	0	15	0	15
1/ 9	0	3	1	0	0	1	2	2	2	0	0	0	11	0	11
1/10	0	3	0	0	1	0	3	5	1	0	0	0	13	0	13
1/11	0	3	1	1	0	0	4	4	1	0	0	0	14	0	14
1/12	2	1	0	1	0	0	2	0	3	0	0	0	9	0	9

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>East Island--Continued</b>															
1/13	1	0	0	1	1	1	1	2	2	0	0	0	9	0	9
1/15	2	2	1	2	0	1	5	3	2	0	0	0	18	0	18
1/16	3	4	2	2	2	2	1	0	1	0	0	0	17	0	17
1/17	1	3	1	2	3	4	5	1	0	0	0	0	20	0	20
1/19	1	1	2	1	2	0	4	0	3	0	0	0	14	0	14
1/20	0	2	3	1	3	1	3	1	2	0	0	0	16	0	16
1/21	0	4	2	0	0	3	4	6	4	0	0	0	23	0	23
1/24	1	0	3	0	0	1	3	3	4	0	0	0	15	0	15
1/25	0	2	2	0	2	1	2	4	2	0	0	0	15	0	15
2/26	0	2	1	0	3	3	1	0	0	0	0	0	10	0	10
3/10	1	4	0	0	3	2	2	0	1	2	0	0	13	2	15
3/12	0	7	0	2	0	3	1	1	0	2	0	0	14	2	16
3/16	0	1	0	1	0	1	2	3	2	0	0	0	10	0	10
3/23	1	2	1	0	0	3	2	1	0	0	0	1	10	1	11
3/30	1	3	1	0	0	0	0	1	1	2	0	0	7	2	9
4/11	0	9	2	0	0	0	1	1	1	2	1	4	14	7	21
4/14	2	8	0	0	0	1	2	3	0	1	0	5	16	6	22
4/17	3	10	4	0	0	2	2	1	0	2	1	3	22	6	28
4/21	1	12	1	0	0	0	0	0	0	1	0	9	14	10	24
4/27	1	12	0	0	1	1	2	2	0	2	2	9	19	13	32
5/ 2	1	11	4	0	1	0	0	3	0	2	1	9	20	12	32
5/ 6	0	13	2	0	0	0	0	0	0	3	3	10	15	16	31
5/11	1	12	1	0	0	1	1	1	0	2	1	7	17	10	27
5/12	0	17	1	0	1	0	0	1	0	2	3	12	20	17	37
5/20	1	14	1	0	0	3	1	1	0	3	1	11	21	15	36
5/21	0	17	0	0	0	1	0	1	0	3	5	9	19	17	36
5/22	0	17	0	0	0	1	0	1	0	3	2	11	19	16	35
5/30	0	18	2	0	0	0	0	1	0	4	1	14	21	19	40
6/ 4	2	23	2	0	0	0	0	0	0	4	2	15	27	21	48
6/ 6	3	18	3	1	1	0	0	1	0	6	5	13	27	24	51
6/ 9	3	21	4	0	1	0	1	0	0	9	4	13	30	26	56
6/11	0	20	3	0	0	1	0	3	1	6	3	13	28	22	50
6/14	5	21	0	0	2	0	1	4	0	6	2	17	33	25	58
6/19	1	13	5	1	1	2	0	2	2	6	5	13	27	24	51
6/21	3	12	4	2	1	0	2	1	1	7	5	12	26	24	50
6/25	0	13	4	1	0	2	1	1	1	8	8	7	23	23	46
6/27	1	12	1	2	3	0	1	2	0	3	5	8	22	16	38
7/ 8	4	13	2	2	2	2	0	1	1	10	10	7	27	27	54
7/13	1	11	1	2	3	0	1	2	2	8	11	5	23	24	47
7/15	0	7	6	0	1	2	1	1	1	2	1	3	19	6	25
7/20	2	11	5	2	2	1	1	2	0	9	9	1	26	19	45
7/27	1	11	7	0	0	9	5	3	1	9	7	5	37	21	58
7/29	2	11	8	0	5	9	1	2	4	10	9	4	42	23	65
8/ 2	3	9	5	2	5	5	3	2	4	7	9	2	38	18	56
8/ 7	3	10	7	1	0	11	0	3	1	6	9	4	36	19	55



## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>East Island--Continued</b>															
8/20	0	7	6	2	2	4	2	1	5	4	7	3	29	14	43
8/21	0	10	3	3	0	2	0	3	6	5	5	1	27	11	38
8/28	3	5	6	2	1	4	6	6	8	6	7	5	41	18	59
9/21	1	4	5	0	0	4	2	1	5	1	2	2	22	5	27
10/17	1	0	2	0	2	6	0	1	7	5	4	1	19	10	29
Mean	1.1	8.1	2.3	0.6	1.0	1.8	1.6	2.0	1.6	2.8	2.5	4.4	20.2	9.7	29.9

<b>Gin Island</b>															
1/ 5	1	1	1	0	0	0	0	1	0	0	0	0	4	0	4
1/ 6	2	2	3	0	1	1	2	1	1	0	0	0	13	0	13
1/ 7	2	0	1	1	1	0	1	1	0	0	0	0	7	0	7
1/ 9	4	0	5	0	0	4	0	0	5	0	0	0	18	0	18
1/10	4	0	1	1	0	2	2	0	0	0	0	0	10	0	10
1/11	0	1	0	0	0	0	0	2	0	0	0	0	3	0	3
1/14	1	1	2	0	0	0	0	1	2	0	0	0	7	0	7
1/15	2	2	1	1	0	0	0	3	2	0	0	0	11	0	11
1/20	0	0	1	0	0	0	1	1	0	0	0	0	3	0	3
1/21	1	0	2	0	0	2	0	0	0	0	0	0	5	0	5
1/24	1	0	1	0	0	0	1	3	1	0	0	0	7	0	7
1/25	0	0	0	0	1	0	1	0	0	0	0	0	2	0	2
3/12	2	0	6	1	0	0	0	1	0	0	0	0	10	0	10
3/16	2	0	1	1	3	2	0	0	0	0	0	0	9	0	9
3/23	1	0	0	0	1	2	1	1	0	0	0	0	6	0	6
3/30	1	0	3	0	1	2	2	1	0	0	0	0	10	0	10
4/16	2	3	2	1	0	1	1	2	1	0	0	0	13	0	13
4/21	4	2	1	1	1	3	0	0	1	0	0	0	13	0	13
4/26	1	0	1	1	2	0	1	0	0	0	0	0	6	0	6
5/ 6	1	2	3	2	0	0	1	0	0	0	0	0	9	0	9
5/11	1	0	2	0	0	2	0	3	4	0	0	0	12	0	12
6/ 9	0	0	0	0	0	0	1	1	0	0	1	0	2	1	3
6/26	1	2	2	0	0	6	0	0	2	0	1	0	13	1	14
7/ 7	0	3	3	1	1	1	0	1	1	0	1	0	11	1	12
7/14	2	3	2	0	0	0	0	0	0	0	1	0	7	1	8
7/21	1	2	0	1	0	1	0	0	0	1	1	0	5	2	7
7/28	0	3	3	1	1	1	0	1	3	0	0	1	13	1	14
8/ 8	1	1	3	0	0	0	0	0	1	0	1	0	6	1	7
8/20	1	3	1	4	1	4	4	1	2	0	1	1	21	2	23
8/28	1	5	4	1	1	5	3	2	3	1	0	0	25	1	26
10/17	1	0	2	1	0	2	2	1	0	0	0	0	9	0	9
Mean	1.3	1.2	1.8	0.6	0.5	1.3	0.8	0.9	0.9	0.1	0.2	0.1	9.4	0.4	9.7

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
Little Gin Island															
1/ 5	1	0	0	0	1	0	0	0	0	0	0	0	2	0	2
1/ 6	1	1	1	0	3	0	0	1	3	0	0	0	10	0	10
1/ 7	2	1	0	0	0	1	1	0	0	0	0	0	5	0	5
1/11	3	1	2	1	1	0	2	0	1	0	0	0	11	0	11
1/12	1	0	1	0	0	0	1	3	0	0	0	0	6	0	6
1/14	2	2	2	0	0	1	2	2	0	0	0	0	11	0	11
1/15	3	1	1	0	1	1	1	2	1	0	0	0	11	0	11
1/20	0	0	3	1	0	0	0	1	1	0	0	0	6	0	6
1/21	0	1	1	0	0	2	0	0	2	0	0	0	6	0	6
1/24	1	1	2	0	0	0	1	1	1	0	0	0	7	0	7
1/25	3	4	0	0	0	1	2	1	1	0	0	0	12	0	12
3/12	3	1	1	0	0	2	0	2	0	0	0	1	9	1	10
3/16	1	2	4	0	0	0	2	0	0	0	0	1	9	1	10
3/23	2	2	0	0	0	0	2	0	0	1	0	1	6	2	8
3/30	0	2	1	0	0	0	0	1	0	1	0	1	4	2	6
4/11	0	0	0	0	0	1	1	1	1	0	1	0	4	1	5
4/16	2	1	1	0	0	1	3	1	1	0	0	0	10	0	10
4/21	0	1	1	0	0	0	0	1	1	0	1	1	4	2	6
4/26	0	3	0	1	1	0	1	3	0	1	2	1	9	4	13
5/ 6	2	3	0	0	1	1	0	0	1	0	0	2	8	2	10
5/11	2	1	2	0	1	0	0	0	0	0	1	1	6	2	8
6/ 9	2	2	1	1	0	0	0	0	0	0	0	3	6	3	9
6/26	1	2	4	0	1	5	3	1	1	1	1	1	18	3	21
7/ 7	4	2	1	0	1	0	4	1	3	2	1	0	16	3	19
7/14	1	1	2	1	2	1	0	1	0	1	1	0	9	2	11
7/21	1	3	0	1	0	1	1	1	1	1	1	0	9	2	11
7/28	1	4	3	2	2	2	5	2	2	1	0	0	23	1	24
8/ 8	3	6	3	2	1	5	3	1	0	2	0	0	24	2	26
8/20	2	2	5	2	0	3	6	2	1	1	1	0	23	2	25
8/28	1	4	4	1	3	4	4	1	1	1	0	0	23	1	24
10/17	1	1	1	0	2	2	3	0	0	1	1	0	10	2	12
Mean	1.5	1.8	1.5	0.4	0.7	1.1	1.5	1.0	0.7	0.5	0.4	0.4	10.2	1.2	11.5

[illegible]

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Mullet Island--Continued</b>															
3/10	0	0	2	0	0	1	0	0	2	0	0	0	5	0	5
3/12	0	3	2	0	0	1	0	0	1	0	0	0	7	0	7
3/16	1	1	3	0	0	1	0	0	0	0	0	1	6	1	7
3/20	0	1	3	0	0	0	0	0	0	0	0	1	4	1	5
3/23	0	1	3	0	0	1	0	0	0	0	0	1	5	1	6
3/30 <sup>a</sup>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/10 <sup>a</sup>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0.1	0.4	1.0	0	0	0.6	0.1	0.1	0.4	0	0	0.2	2.6	0.2	2.9
<b>Round Island</b>															
1/ 6	0	1	1	0	0	0	1	0	0	0	0	0	3	0	3
1/ 8	0	0	0	0	0	0	1	1	0	0	0	0	2	0	2
1/ 9	0	0	1	0	0	2	0	0	0	0	0	0	3	0	3
1/11	0	1	0	0	0	0	0	0	1	0	0	0	2	0	2
1/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/21	0	1	1	0	0	0	0	0	0	0	0	0	2	0	2
1/25	1	1	0	1	0	0	0	0	0	0	0	0	3	0	3
2/26	0	1	0	0	0	1	0	0	0	0	0	1	2	1	3
3/10	0	2	1	0	0	0	0	0	1	1	0	2	4	3	7
3/12	1	2	0	0	0	0	0	0	0	1	0	2	3	3	6
3/16	0	1	0	0	0	1	0	0	1	0	0	1	3	1	4
3/20	1	1	0	0	0	0	0	0	0	0	0	1	2	1	3
3/23	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
4/10	0	4	3	0	0	0	0	0	0	0	0	3	7	3	10
4/20	0	3	0	0	0	0	0	0	0	0	0	4	4 <sup>b</sup>	4	8
4/25	0	3	2	1	0	1	0	0	0	0	0	4	7	4	11
5/ 1	1	4	2	0	0	0	0	0	0	0	1	4	7	5	12
5/ 6	0	4	0	0	0	0	0	0	0	0	0	4	4	4	8
5/10	0	6	3	0	0	0	0	0	0	0	1	7	9	8	17
5/20	0	8	4	0	0	0	0	0	1	0	0	6	3	6	19
5/22	1	9	0	0	0	0	0	0	0	0	0	9	10	9	19
5/29	0	7	0	0	0	0	0	0	0	0	0	8	7	8	15
6/ 3	0	8	2	0	0	0	0	0	0	0	0	11	10	11	21
6/ 8	0	11	0	0	0	0	0	0	0	0	0	14	11	14	25
6/16	0	11	1	0	0	0	0	0	2	0	0	17	14	17	31
6/23	0	8	0	0	0	0	0	0	0	1	0	14	8	15	23
6/28	0	9	0	0	0	1	0	0	0	1	0	13	10	14	24
7/ 7	0	3	0	0	0	0	0	0	0	1	0	9	3	10	13
7/13	0	6	1	0	0	0	0	0	0	0	1	14	7	15	22
7/15	0	4	1	0	1	1	0	1	0	4	0	9	8	13	21
7/20	0	6	1	0	0	2	1	0	0	0	0	12	10	12	22

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Round Island--Continued</b>															
7/26	0	2	0	0	0	0	0	0	0	0	0	9	2	9	11
7/30	1	3	1	0	0	0	0	0	0	1	0	7	5	8	13
8/ 1	0	3	1	0	0	0	0	0	0	2	0	10	4	12	16
8/ 4	0	2	1	0	0	0	0	0	1	0	0	13	4	13	17
8/ 6	1	1	1	0	0	0	0	0	1	0	0	10	4	10	14
8/ 9	0	1	0	0	0	0	0	0	0	1	0	9	1	10	11
8/20	0	1	3	0	0	1	0	0	1	1	0	2	6	3	9
8/21	0	0	0	0	0	0	0	0	0	1	0	11	0	12	12
8/28	1	1	1	0	0	0	0	0	2	3	2	6	5	11	16
8/30	1	1	0	0	0	0	0	0	0	0	0	9	2	9	11
9/21	0	1	0	0	0	2	0	0	1	0	0	3	4	3	7
10/17	0	0	0	0	0	1	0	0	0	0	1	0	1	1	2
Mean	0.2	3.3	0.7	0	0	0.3	0.1	0	0.3	0.4	0.1	6.0	5.0	6.6	11.6
<b>Shark Island</b>															
1/ 6	5	1	8	2	1	3	1	1	0	0	0	0	22	0	22
1/11	0	0	0	0	0	0	1	0	0	0	0	0	21 <sup>b</sup>	0	21
1/14	3	0	2	2	0	4	0	1	1	0	0	0	13	0	13
1/15	2	0	4	2	1	2	1	1	3	0	0	0	16	0	16
1/20	2	3	3	0	0	3	0	0	4	0	0	0	15	0	15
1/21	4	4	8	1	0	7	0	2	1	0	0	0	27	0	27
3/13	0	0	7	0	0	3	0	0	0	0	0	0	11 <sup>b</sup>	0	11
3/20	4	1	1	1	0	4	2	3	2	0	0	0	18	0	18
4/19	0	1	1	1	0	1	0	0	0	0	0	0	4	0	4
7/ 9	1	1	2	0	0	0	0	0	0	0	0	0	4	0	4
Mean	2.1	1.1	3.6	0.9	0.2	2.7	0.5	0.8	1.1	0	0	0	15.1	0	15.1
<b>Tern Island</b>															
1/ 2	11	6	7	3	6	12	4	5	1	0	0	0	55	0	55
1/ 6	11	5	3	10	2	10	9	4	4	0	0	0	58	0	58
1/ 7	7	5	7	3	3	4	4	7	7	0	0	0	47	0	47
1/ 8	13	1	9	1	2	6	2	4	7	0	0	0	45	0	45
1/ 9	12	5	6	4	2	2	4	3	2	0	0	0	40	0	40
1/10	12	5	6	3	4	4	5	1	1	0	0	0	41	0	41
1/11	10	5	6	3	4	3	1	3	3	0	0	0	38	0	38
1/12	10	6	8	3	1	2	2	3	3	0	0	0	38	0	38
1/13	4	7	13	0	0	0	1	3	3	0	0	0	31	0	31
1/14	17	8	3	7	5	6	0	2	1	0	0	0	49	0	49
1/16	9	16	9	5	2	5	2	9	7	0	0	0	64	0	64
1/18	5	8	7	3	6	3	1	5	5	0	0	0	43	0	43

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Tern Island--Continued</b>															
1/19	5	7	9	2	0	5	0	2	5	0	0	0	35	0	35
1/20	19	5	3	6	6	2	5	4	2	0	0	0	52	0	52
1/21	13	13	15	4	3	8	4	2	2	0	0	0	64	0	64
1/22	14	8	9	5	3	10	4	1	4	0	0	0	58	0	58
1/25	7	7	6	3	2	5	7	5	4	0	0	0	46	0	46
1/26	8	8	5	9	4	3	1	3	1	0	0	0	42	0	42
1/30	11	4	17	5	2	8	2	0	1	0	0	0	50	0	50
2/ 3	8	7	13	6	3	14	1	4	0	0	0	0	56	0	56
2/ 7	8	5	10	11	11	19	1	1	2	0	0	0	68	0	68
2/11	10	11	13	12	10	7	2	4	5	0	0	0	74	0	74
2/15	20	10	12	14	6	10	0	3	4	0	0	0	79	0	79
2/19	24	11	7	10	10	7	2	4	4	0	0	0	79	0	79
2/23	17	4	5	11	8	13	1	3	1	0	0	0	63	0	63
2/26	12	12	6	15	15	14	2	1	0	0	0	0	77	0	77
2/27	18	9	17	8	9	13	3	2	1	0	0	0	80	0	80
3/ 2	13	6	15	4	8	19	5	6	2	0	0	0	78	0	78
3/ 6	23	10	22	6	9	17	0	3	1	0	0	0	91	0	91
3/10	14	6	11	8	7	20	3	4	2	0	0	0	75	0	75
3/14	7	8	4	5	3	8	5	6	5	0	0	0	51	0	51
3/18	16	4	9	8	8	8	9	8	6	0	0	0	76	0	76
3/22	13	2	10	0	6	6	8	8	6	0	0	0	59	0	59
3/26	18	4	7	2	6	4	5	5	2	0	0	0	53	0	53
3/30	13	7	11	1	3	6	5	3	6	0	0	0	55	0	55
4/ 3	15	4	15	3	4	7	6	7	3	0	0	0	64	0	64
4/ 7	11	6	5	3	2	3	6	8	4	0	0	0	48	0	48
4/ 9	13	4	8	5	6	3	4	6	3	0	0	0	52	0	52
4/11	11	3	9	6	2	8	1	3	4	0	0	0	47	0	47
4/15	11	7	10	4	2	9	3	1	2	0	0	0	49	0	49
4/19	15	2	7	3	4	9	4	2	4	0	0	0	50	0	50
4/23	10	5	8	5	6	4	4	1	3	0	0	0	46	0	46
4/27	5	4	8	4	4	7	2	3	1	0	0	0	38	0	38
5/ 1	8	4	16	0	7	4	3	2	2	0	0	0	46	0	46
5/ 5	12	3	5	1	3	3	1	3	2	0	0	0	33	0	33
5/ 6	16	7	6	2	3	4	1	3	2	0	0	0	44	0	44
5/ 9	12	1	5	9	5	2	0	5	9	0	0	0	48	0	48
5/13	7	2	6	4	1	2	1	4	2	0	0	0	29	0	29
5/16	6	4	6	7	8	3	0	1	0	0	0	0	35	0	35
5/17	8	4	4	6	3	1	1	0	1	0	0	0	28	0	28
5/21	11	8	1	4	8	2	1	2	1	0	0	0	38	0	38
5/25	3	1	1	1	4	1	3	0	2	0	0	0	16	0	16
5/29	9	1	5	2	5	5	3	0	3	0	0	0	33	0	33
6/ 2	3	2	7	3	4	9	2	1	3	0	0	0	34	0	34

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
Tern Island--Continued															
6/ 6	7	4	4	3	1	4	2	0	6	0	0	0	31	0	31
6/ 9	6	5	7	3	3	4	2	4	6	0	0	0	40	0	40
6/10	6	6	11	3	2	5	0	2	5	0	0	0	40	0	40
6/14	4	7	11	5	3	11	6	3	4	0	0	0	54	0	54
6/18	4	5	12	2	3	5	4	2	8	0	0	0	45	0	45
6/22	15	6	6	3	4	4	1	2	0	0	0	0	41	0	41
6/26	10	9	10	2	2	8	1	3	2	0	0	0	47	0	47
6/30	6	6	13	1	3	7	2	1	3	0	0	0	42	0	42
7/ 4	14	6	11	2	1	7	2	2	0	0	0	0	45	0	45
7/ 8	3	10	7	0	3	9	2	3	0	0	0	0	37	0	37
7/12	11	5	15	2	0	10	5	3	1	2	0	0	52	2	54
7/15	8	5	12	3	6	13	5	4	3	2	0	0	59	2	61
7/16	7	10	9	3	5	12	2	1	4	2	0	0	53	2	55
7/20	12	6	7	2	6	11	3	5	7	0	0	0	59	0	59
7/24	7	7	9	1	3	8	3	2	3	0	0	0	43	0	43
7/28	5	16	11	3	9	9	3	4	0	1	0	0	60	1	61
7/31	6	3	4	10	5	5	5	3	7	1	1	0	48	2	50
8/ 5	12	7	9	7	5	10	4	6	4	2	1	0	64	3	67
8/10	8	4	4	11	7	14	3	4	4	0	1	0	59	1	60
8/13	6	5	10	13	4	21	4	5	7	0	0	1	75	1	76
8/17	5	4	2	8	8	23	8	8	9	0	0	0	75	0	75
8/21	12	8	7	13	7	13	1	1	2	0	1	0	64	1	65
8/25	14	5	5	13	6	15	6	6	7	1	1	0	77	2	79
8/29	4	1	8	6	5	18	6	5	9	0	0	0	62	0	62
9/ 2	8	4	13	4	6	11	6	4	12	0	2	0	68	2	70
9/ 6	7	3	8	5	2	9	5	3	9	2	2	0	51	4	55
9/10	10	4	3	2	5	11	1	2	10	0	0	0	48	0	48
9/14	8	3	13	2	3	6	2	6	12	2	2	0	55	4	59
9/18	9	4	7	3	0	6	4	3	13	5	3	0	49	8	57
9/21	3	0	23	0	1	10	2	2	13	1	0	2	54	3	57
9/22	5	5	13	4	2	7	3	2	6	2	0	0	47	2	49
9/26	8	7	9	2	5	14	7	2	6	1	1	0	60	2	62
9/30	16	3	11	3	1	4	4	6	7	0	2	1	55	3	58
10/ 4	19	2	11	4	2	12	4	2	7	1	0	1	63	2	65
10/ 8	12	4	9	7	5	2	4	3	8	2	1	1	54	4	58
10/12	9	5	28	2	7	5	3	4	2	2	2	0	65	4	69
10/16	25	13	26	4	5	9	1	2	2	0	1	0	87	1	88
10/20	20	5	26	5	5	6	0	3	0	0	0	0	70	0	70
10/24	17	5	26	7	9	10	2	1	0	0	0	0	77	0	77
10/28	24	7	25	6	3	12	1	3	0	0	0	1	81	1	82
11/ 1	30	3	25	5	11	8	0	4	1	1	0	0	87	1	88
11/ 5	37	12	30	11	8	8	0	2	3	1	1	0	111	2	113

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Tern Island--Continued</b>															
11/ 9	17	9	28	3	7	10	1	2	0	1	2	0	77	3	80
11/13	32	5	25	5	9	17	1	0	0	1	0	0	94	1	95
11/17	20	10	49	10	1	12	2	2	1	3	1	0	107	4	111
11/21	17	7	26	6	2	13	4	5	20	2	0	0	100	2	102
11/25	27	8	20	4	0	10	5	0	11	2	3	1	85	6	91
11/29	12	3	16	0	4	12	8	6	10	4	2	0	71	6	77
12/ 3	19	5	17	3	6	14	5	1	10	4	3	0	80	7	87
12/ 7	17	5	23	5	7	12	5	1	11	5	0	0	86	5	91
12/11	13	3	14	4	7	16	10	2	19	2	3	0	88	5	93
12/15	16	10	23	6	5	20	3	3	10	2	1	0	96	3	99
12/19	18	7	21	4	6	19	5	2	13	7	3	0	95	10	105
12/27	17	9	18	6	7	14	1	1	7	2	0	0	80	2	82
12/31	25	9	14	8	6	8	3	4	13	5	1	0	90	6	96
Mean	12.2	5.9	11.5	4.9	4.7	8.6	3.1	3.2	4.6	0.7	0.4	0.1	58.6	1.1	59.7
<b>Trig Island</b>															
1/ 1	3	2	10	0	2	5	1	0	2	0	0	0	25	0	25
1/ 2	11	6	8	1	1	1	2	0	1	0	0	0	31	0	31
1/ 3	12	2	14	4	1	3	1	4	4	0	0	0	45	0	45
1/ 4	5	4	8	4	1	7	1	1	2	0	0	0	33	0	33
1/ 5	8	5	9	3	0	3	0	1	1	0	0	0	30	0	30
1/ 6	10	4	7	2	1	3	0	1	0	0	0	0	28	0	28
1/ 7	6	4	8	1	1	5	0	0	1	0	0	0	26	0	26
1/ 8	5	6	5	2	1	1	1	1	0	0	0	0	22	0	22
1/ 9	8	4	8	2	1	2	0	1	0	0	0	0	26	0	26
1/10	1	4	6	0	0	1	0	0	2	0	0	0	14	0	14
1/11	6	2	11	1	1	5	1	1	1	0	0	0	29	0	29
1/12	6	4	3	1	2	2	0	1	0	0	0	0	19	0	19
1/15	6	4	3	5	0	1	0	2	2	0	0	0	23	0	23
1/16	6	4	6	5	3	1	3	2	1	0	0	0	31	0	31
1/17	8	6	11	2	1	2	2	2	1	0	0	0	35	0	35
1/18	11	8	5	8	2	5	1	3	4	0	0	0	47	0	47
1/19	10	5	8	3	0	2	0	4	1	0	0	0	33	0	33
1/20	16	10	1	1	4	2	0	1	0	0	0	0	35	0	35
1/21	12	6	6	5	2	3	1	2	0	0	0	0	37	0	37
1/23	5	5	12	0	0	2	1	2	0	0	0	0	27	0	27
1/24	15	12	6	2	0	2	3	1	3	0	0	0	44	0	44
2/26	4	4	1	3	2	7	3	1	0	0	0	0	25	0	25
3/10	2	5	5	2	2	6	3	4	3	0	0	0	32	0	32
3/12	6	8	6	1	0	6	2	3	4	0	0	0	36	0	36
3/20	3	4	5	1	3	4	2	3	2	0	0	0	27	0	27

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Trig Island--Continued</b>															
3/25	3	0	3	0	2	1	2	3	4	0	0	0	18	0	18
3/30	0	1	5	0	0	3	0	0	2	0	0	0	11	0	11
4/10	1	2	1	0	0	0	1	1	1	0	0	0	7	0	7
4/16	3	3	3	0	0	2	0	0	0	0	0	0	11	0	11
4/20	2	3	1	0	2	1	0	1	1	0	0	0	11	0	11
4/25	1	3	3	1	1	1	0	0	0	0	0	0	10	0	10
5/ 1	3	2	2	2	1	1	1	0	0	0	0	0	12	0	12
5/ 6	2	3	3	1	0	2	0	0	0	0	0	0	11	0	11
5/10	2	0	2	0	2	1	0	1	3	0	0	0	11	0	11
5/19	3	0	0	2	1	0	2	1	1	0	0	0	10	0	10
5/29	1	1	0	1	1	0	1	0	0	0	0	0	5	0	5
6/ 7	1	2	1	0	0	1	1	1	1	1	1	0	8	2	10
6/ 9	2	1	1	0	0	0	0	1	1	0	0	0	6	0	6
6/13	1	2	3	0	0	0	1	0	0	0	1	0	7	1	8
6/18	1	0	8	0	0	0	1	0	1	0	1	0	11	1	12
6/28	0	0	5	1	1	1	1	1	3	0	0	0	13	0	13
7/ 5	8	7	3	0	1	0	0	1	0	0	0	0	20	0	20
7/11	2	3	2	3	3	2	3	2	0	0	1	0	20	1	21
7/15	1	2	5	2	2	4	1	1	1	0	1	0	19	1	20
7/18	1	5	5	2	2	8	1	0	0	1	0	0	24	1	25
7/26	1	6	1	3	2	5	0	2	0	0	0	1	20	1	21
8/ 1	1	4	6	0	5	3	0	2	5	0	0	0	26	0	26
8/ 6	2	5	2	4	4	4	0	3	1	1	1	0	25	2	27
8/17	1	2	3	4	1	4	1	5	1	0	0	0	22	0	22
8/21	0	1	2	0	0	3	4	1	2	0	1	0	13	1	14
9/21	0	2	0	1	1	4	0	1	6	4	1	0	15	5	20
Mean	4.5	3.7	4.7	1.7	1.2	2.6	1.0	1.4	1.4	0.1	0.2	0	22.1	0.3	22.4

**Whale-Skate Island**

1/ 1	12	4	5	2	1	5	6	3	4	0	0	0	42	0	42
1/ 2	7	3	5	4	4	0	4	10	5	0	0	0	42	0	42
1/ 3	4	4	6	3	2	3	4	2	1	0	0	0	29	0	29
1/ 4	6	3	4	2	1	6	2	4	3	0	0	0	31	0	31
1/ 5	5	3	1	6	0	1	7	11	3	0	0	0	37	0	37
1/ 6	3	4	6	4	1	2	12	13	6	0	0	0	51	0	51
1/ 7	2	8	6	2	1	2	10	6	3	0	0	0	40	0	40
1/ 8	2	5	2	4	3	1	4	6	4	0	0	0	31	0	31
1/ 9	0	3	6	0	3	4	4	4	3	0	0	0	27	0	27
1/10	1	2	9	1	3	4	5	8	3	0	0	0	36	0	36
1/11	9	5	5	1	7	1	4	9	3	0	0	0	44	0	44
1/12	2	2	5	2	3	2	8	4	2	0	0	0	30	0	30



## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Whale-Skate Island--Continued</b>															
1/13	4	4	7	0	1	5	4	7	3	0	0	0	35	0	35
1/15	7	5	2	1	1	2	3	7	7	0	0	0	35	0	35
1/16	3	3	3	0	0	6	1	1	8	0	0	0	25	0	25
1/17	7	4	8	0	0	3	7	5	6	0	0	0	40	0	40
1/18	6	5	3	3	2	1	9	14	5	0	0	0	48	0	48
1/20	2	4	9	1	4	7	8	6	7	0	0	0	48	0	48
1/21	6	12	3	5	5	3	9	10	5	0	0	0	58	0	58
1/22	0	7	5	0	0	5	5	8	8	0	0	0	38	0	38
1/23	0	3	6	0	0	1	1	2	0	0	0	0	13	0	13
1/24	1	3	8	2	3	6	3	7	3	0	0	0	36	0	36
1/25	4	2	4	0	3	3	10	6	3	0	0	0	35	0	35
2/26	4	4	7	5	5	11	8	6	3	0	0	0	53	0	53
3/10	2	3	2	2	4	6	4	8	5	0	0	0	36	0	36
3/12	6	2	0	5	3	2	6	16	5	0	0	0	45	0	45
3/20	4	2	3	2	3	1	10	6	1	0	0	0	32	0	32
3/25	5	3	1	5	1	0	8	7	2	0	0	0	32	0	32
3/30	3	6	3	0	0	9	6	4	2	0	1	0	33	1	34
4/10	1	4	1	0	0	2	11	5	6	0	1	2	30	3	33
4/14	1	5	3	1	1	6	3	3	6	0	1	2	29	3	32
4/17	2	7	3	0	3	2	1	2	2	0	0	1	22	1	23
4/20	1	4	1	0	3	3	3	3	2	0	1	1	20	2	22
4/25	2	8	2	2	4	2	3	1	0	0	1	2	24	3	27
5/ 1	0	4	5	2	6	5	1	2	0	1	1	1	25	3	28
5/ 6	5	4	3	2	4	0	3	2	3	1	0	3	26	4	30
5/10	1	4	2	3	1	1	4	5	0	1	0	0	21	1	22
5/19	2	7	4	3	2	2	5	5	0	3	1	1	30	5	35
5/22	4	8	2	0	3	0	0	3	0	3	1	3	20	7	27
5/29	2	11	8	0	0	5	3	4	8	5	2	3	41	10	51
6/ 1	6	9	10	3	1	1	3	2	5	1	1	4	40	6	46
6/ 3	4	14	2	0	1	5	0	2	0	5	2	0	28	7	35
6/ 9	5	13	1	2	2	4	3	3	1	4	1	5	34	10	44
6/11	3	15	0	3	4	3	5	2	3	5	2	4	38	11	49
6/14	4	17	12	2	3	6	3	2	1	8	2	3	50	13	63
6/19	3	15	9	0	0	2	1	3	7	3	2	5	40	10	50
6/25	4	15	4	1	1	5	4	1	1	4	2	3	36	9	45
6/27	3	14	10	4	3	3	3	2	0	5	1	4	42	10	52
7/ 6	5	19	8	2	3	0	4	5	2	7	5	5	48	17	65
7/12	4	15	4	1	5	6	6	4	3	6	6	3	48	15	63
7/15	3	15	7	1	3	11	4	3	4	6	5	5	51	16	67
7/19	2	19	4	3	2	1	2	3	2	8	5	7	38	20	58
7/27	5	14	9	4	2	11	6	5	5	12	4	3	61	19	80

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
<b>Whale-Skate Island--Continued</b>															
7/29	1	9	12	2	7	4	4	3	5	5	5	5	47	15	62
8/ 2	2	12	9	3	6	3	5	4	2	11	2	5	46	18	64
8/ 4	2	12	8	3	4	7	4	3	1	4	1	4	44	9	53
8/ 7	3	14	4	5	4	9	4	2	6	9	5	6	51	20	71
8/ 8	1	14	8	5	5	3	7	4	4	2	2	6	51	10	61
8/17	5	12	6	4	2	6	6	5	5	9	5	8	51	22	73
8/21	2	10	4	4	8	9	4	7	10	8	3	2	58	13	7
9/21	2	4	10	1	3	5	3	3	8	7	7	3	39	17	56
10/17	3	5	5	0	2	3	7	6	5	11	4	0	36	15	51
Mean	3.4	7.6	5.1	2.1	2.6	3.8	4.8	5.0	3.5	2.5	1.3	1.8	37.9	5.6	43.4
<b>Sand spit east of East Island</b>															
4/21 <sup>a</sup>	0	1	2	0	0	1	0	0	1	0	0	0	5	0	5
Mean	0	1.0	2.0	0	0	1.0	0	0	1.0	0	0	0	5.0	0	5.0

<sup>a</sup>Island awash.<sup>b</sup>Total includes some seals which were not placed in any size class.

Appendix D.--Hawaiian monk seal necropsy reports, French Frigate Shoals, 1984.

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**NECROPSY NO.:** JJE001

**DATE OF DEATH:** Estimated 0-2 days prior to necropsy

**DATE OF NECROPSY:** 25 March 1984

**ISLAND:** Whale-Skate Island

**SEX:** Male

**SIZE:** Newborn pup

**CIRCUMSTANCES OF DEATH:** Adult female Y144 was attending dead pup. Postmortem autolysis was too severe for adequate histologic appraisal; however, the pup was probably stillborn.

**EXTERNAL DESCRIPTION:** Placenta attached to pup; blood around nasal area; no visible wounds.

*Measurements:* Standard length (dorsal side up)--89.0 cm  
 Curvilinear length-----95.6 cm  
 Anterior length foreflipper-----17.2 cm  
 Anterior length hind flipper-----19.3 cm  
 Axillary girth-----43.5 cm  
 Blubber thickness (at sternum)-----0.4 cm

**INTERNAL:** No stomach contents.

**SAMPLES COLLECTED:** Adrenal, heart, kidney, liver, lung, pancreas, skull, spleen.

## Appendix D.--Continued.

**NECROPSY NUMBER:** JJE002  
**DATE OF DEATH:** 12 April 1984 between 0910 and 1730 hours  
**DATE OF NECROPSY:** 12 April 1984 at 1730 hours  
**ISLAND:** Tern Island  
**SEX:** Female  
**SIZE:** Juvenile

**CIRCUMSTANCES OF DEATH:** Seal had been sighted alive at 0910 hours. The immediate cause of death was probably starvation.

**EXTERNAL DESCRIPTION:** No visible wounds. Seal was very emaciated.

*Measurements:* Standard length (dorsal side up)--125.0 cm  
 Curvilinear length-----132.0 cm  
 Anterior length foreflipper-----25.5 cm  
 Anterior length hind flipper-----27.0 cm  
 Axillary girth-----55.0 cm  
 Blubber thickness (at sternum)-----1.0 cm  
 Weight-----18.2 kg

**INTERNAL:** Foam in the trachea and nostrils; stomach contained orange-yellow liquid and parasites. One 0.5-cm-diameter lesion in stomach lining.

**SAMPLES COLLECTED:** Adrenal, blubber, endoparasites, heart, kidney, liver, lung, muscle, ovary, pancreas, skull, spleen, stomach contents.

## Appendix D.--Continued.

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**NECROPSY NUMBER:** JJE005

**DATE OF DEATH:** Estimated 2-3 days prior to necropsy.

**DATE OF NECROPSY:** 19 May 1984

**ISLAND:** Whale-Skate Island

**SEX:** Female

**SIZE:** Juvenile

**CIRCUMSTANCES OF DEATH:** Postmortem autolysis was too severe for adequate histologic appraisal.

**EXTERNAL DESCRIPTION:** Seal was bloated with blood around nasal and mouth area. Left side of head damaged and left eye missing, but this may have been due to decomposition and insect foraging. No other visible wounds.

**Measurements:**

Standard length (dorsal side up)	--141.0 cm
Curvilinear length	-----143.5 cm
Anterior length foreflipper	-----25.0 cm
Anterior length hind flipper	-----25.5 cm
Axillary girth	-----79.0 cm
Blubber thickness (at sternum)	-----0.8 cm

**INTERNAL:** Stomach and intestine empty.

**SAMPLES COLLECTED:** Adrenal, blubber, endoparasites, heart, kidney, liver, lung, muscle, ovary, pancreas, skull, spleen.

## Appendix D.--Continued.

**NECROPSY NUMBER:** JJE008  
**DATE OF DEATH:** 3 August (1600 hours)-4 August (0900 hours)  
**DATE OF NECROPSY:** 4 August 1984  
**ISLAND:** Whale-Skate Island  
**SEX:** Male  
**SIZE:** Adult

**CIRCUMSTANCES OF DEATH:** Seal was sighted on 2 and 3 August and appeared very emaciated, weak, and possibly blind. On the morning of 4 August, the seal was found dead. Histologic examination revealed debilitating lung pathology, the cause of which could not be identified.

**EXTERNAL DESCRIPTION:** Seal was very emaciated. Blood around nasal area.

*Measurements:* Standard length (dorsal side up)--183.0 cm  
 Curvilinear length-----184.5 cm  
 Anterior length foreflipper-----33.0 cm  
 Anterior length hind flipper-----32.5 cm  
 Axillary girth-----91.0 cm  
 Blubber thickness (at sternum)-----1.2 cm

**INTERNAL:** Stomach and intestine empty, fluid in chest cavity; fat globule in heart 7 x 2 cm; foam in trachea; gall bladder very large.

**SAMPLES COLLECTED:** Adrenal, blubber, endoparasites, gall bladder, heart, kidney, liver, lung, muscle, pancreas, skull, stomach contents, testis.

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